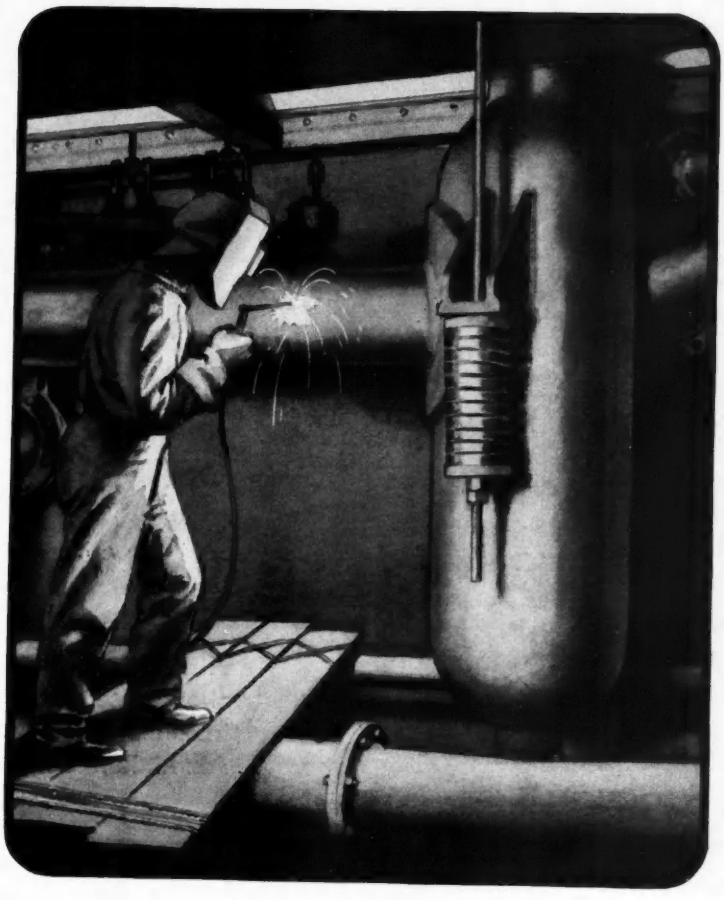
The Engineer

VOL. CXC—No. 4935 28, ESSEX ST., STRAND, LONDON, W.C.2 AUGUST 25, 1950

Established 1856 Price 1s. 6d. By Inland Post 1s. 9d. Registered as a Newspaper

UNIVERSITY OF MICHIGAN
SEP 11 1950
ENGINEERING LIBRARY



THE STEEL TUBE AGE

Welding a Dawson joint
on a high pressure, high temperature S & L steam main
in a modern power station.

STEWARTS AND LLOYDS LIMITED
GLASGOW · BIRMINGHAM · LONDON

S&L

35" x 96" Reversing Hot Breaking Down Mill for the production of aluminium alloy plate and coiled stock. Recently installed at the works of The Northern Aluminium Co., Ltd., Rogerstone.

BRIGHTSIDE

HOT & COLD ROLLING MILLS for ferrous & non-ferrous products

THE BRIGHTSIDE FOUNDRY & ENGINEERING CO. LTD
SHEFFIELD · P.O. BOX 118

A Seven-Day Journal

The Industrial Finishes Exhibition

Much interest attaches to the first Industrial Finishes Exhibition, which is to be held at Earls Court, London, from Wednesday next, August 30th, until Thursday, September 7th. At this exhibition, which will cover a very important side of industry, there will be shown a representative range of the many and varied industrial finishes now available in this country, particularly those applicable to metal products. In view of the prominent part finish now plays in the engineering industry, both from the angle of protection and the appeal which a well finished unit or machine has to the prospective buyer, the exhibition will be well worth a visit from all designers and executives connected with marketing. According to preliminary information available excellent facilities will be given on the many industrial stands at Earls Court for the detailed inspection and comparison of a wide range of the equipment and processes now available to industry for finishing products of all kinds. The organisers have designed a central technical exhibit, on which will be shown examples of the various finishes available and their suitability for different purposes. This exhibit will be divided into seven sections, showing natural metal finishes, plated finishes, hot-dipped coatings, sprayed metal finishes, vitreous enamel, organic finishes, including lacquers and paints, and the anodising and dyeing of aluminium. In a hall of colour a series of demonstrations will cover a wide historical range of colours, showing actual manufactured products of historic note, together with an analysis of the colours used therein and their modern equivalents.

Merchant Shipping Casualties

The Ministry of Transport has resumed the publication of the annual "Return of Shipping Casualties and Deaths." The return just issued gives statistics of casualties due to marine peril for the year 1948. Referring to power driven vessels of 100 gross tons and over, it states that the total losses for the year amounted to 30,378 tons, representing 52 per cent of the losses in 1947 and 47 per cent of the 1946 figure. This big reduction has resulted chiefly from the small amount of tonnage lost by strandings, which amounted to only one-eighth of the tonnage lost, as against more than one-third for other years. Only one passenger vessel, of 4220 gross tons, was lost and of those without a passenger certificate twelve vessels, of 10,434 gross tons, carrying cargo, and eight vessels, of 15,724 gross tons, in ballast, were lost, compared with eleven vessels of 33,341 gross tons and nine of 26,413 gross tons in 1947. The report notes that no vessel of 10,000 gross tons or over was lost during 1946, 1947 and 1948. Casualties other than total losses were the lowest since 1934, the number being ninety-two vessels, totalling 367,427 gross tons, four (24,288 gross tons) being passenger vessels. Of those without passenger certificate sixty-two (246,437 gross tons) carried cargo, and twenty-six (96,702 gross tons) were in ballast, the corresponding returns for 1947 being three vessels (39,648 gross tons), sixty-one vessels (206,279 gross tons), and thirty-three vessels (179,650 gross tons). The number of minor casualties is given as 2527, the highest number recorded since 1929 and greater than in 1946 and 1947, when the figures were, respectively, 2505 and 2381.

Reorganisation of Railway District Commercial Offices

As a further step towards simpler and unified contact between British Railways and the trading and travelling public, the Railway Executive has approved a reorganisation of the district commercial offices in the Eastern, London Midland, North-Eastern and Western Regions of British Railways. The reorganisation in the Scottish Region was carried out last year, when twelve Scottish district commercial offices were reduced to eight. Office rearrangements in the Southern Region will, it is stated, shortly follow. This reorganisation, which will come into effect almost at once in most districts, will obviate overlapping and duplication of railway commercial offices in important centres hitherto served by two Regions, such as Sheffield, Manchester, Swansea and Bristol. The scheme is thus linked with the revision, carried out in April this year, of the regional boundaries of British Railways; it will lead to a reduction from fifty-nine to forty-six in the total number of district commercial offices in the four Regions at present affected. The new organisation will also provide a foundation for the closer analysis of traffic flows, routing and the re-examination of the use of terminal facilities, so that by making the fullest use of all available resources still further improvements in service and quicker transits can be afforded to the public. With the object of helping towards the co-ordination of rail and road resources and towards the fulfilment of transport integration in accordance with the policy of the British Transport Commission, the boundaries of the new railway commercial districts are as far as possible being made coterminous with those of the Road Haulage Executive's organisation.

"Energy in the Service of Man"

In connection with the forthcoming annual meeting of the British Association for the Advancement of Science, an exhibition was opened at Birmingham University on Tuesday last, which portrays examples of scientific achievement throughout the ages. In declaring the exhibition open, Sir Harold Hartley, President of the British Association, said that it owed its origin to Mr. George Cadbury, who had suggested that some tribute should be paid to pioneers like Boulton, Watt and Murdoch for their contributions to the industrial revolution. As the theme of the Association's meeting was to be "Energy in the Service of Man," it was appropriate, Sir Harold said, that the exhibition had been extended to cover the latest developments in the field of energy. The exhibition is to be open to the public until August 29th and for another period, September 7th to 9th, at the end of the British Association meetings. In addition to the exhibition, a series of public lectures is being given in the Midland Institute, Paradise Street, Birmingham. Those delivered this week include "Birmingham and the Industrial Revolution," by Mr. W. K. V. Gale; "Power—its Production and Distribution," by Mr. J. R. Beard, M.I.C.E., M.I.E.E.; "Man's Use of Solar Energy," by Dr. A. Parker; and "Gaseous Fuels and their Significance for the Future," by Professor F. H. Garner. The final lecture in the series will be given on September 5th by Professor Sir Alfred Egerton, F.R.S., on "Energy and Civilisation."

A Chief Executive for Guided Weapons

An announcement made jointly this week by the Air Ministry and the Ministry of Supply says that Air Chief Marshal Sir W. Alec Coryton, K.C.B., Controller of Supplies (Air) in the Ministry of Supply, is to become Chief Executive, Guided Weapons. It is stated that this post has been created at the Ministry of Supply with the object of accelerating and co-ordinating all work on the research, development and production of guided weapons. Sir Alec Coryton was commissioned in the Rifle Brigade in September, 1914, and transferred to the Royal Air Force in April, 1918. Between the wars he held various posts at home and overseas, and in September, 1939, he became Director of Operations Overseas, at the Air Ministry. Sir Alec commanded No. 5 Group Bomber Command in 1942, and was later appointed Air Officer Commanding Third Tactical Air Force, South-East Asia Command. In October, 1945, he joined the Ministry of Aircraft Production as Controller of Research and Development, which post became designated Controller of Supplies (Air) when the Ministries of Supply and Aircraft Production were amalgamated in 1946. Air Vice-Marshal J. N. Boothman, C.B., will succeed Sir Alec Coryton as Controller of Supplies (Air) and will thus become responsible for research, design, development, production and inspection in the aircraft field. Both appointments take effect on September 4th.

Siliceous Parting Powders in Foundries

The Minister of Labour has given notice that he proposes to make Special Regulations entitled the Foundries (Parting Materials) Special Regulations, 1950, in accordance with a draft headed "Revised Draft, August, 1950." It is stated that the effect of these Regulations would be to prohibit, in general, the use as a parting material in foundries of any material containing more than 3 per cent of compounds of silicon calculated as silica. The prohibition would not, however, apply to natural sand or to certain specified substances, such as sillimanite, which contain, or might contain, substantial percentages of compounds of silicon other than "free silica." The draft Regulations are almost identical with a previous draft published by the Minister in February, 1950. The only difference is that, in response to representations, it is proposed to add the substance known as "olivine" to the schedule of exempted substances. The Minister has been advised that the use of this substance as a parting powder is not liable to cause silicosis and ought to be permissible under the Regulations. In accordance with the statutory procedure, any objections to the draft Regulations by or on behalf of persons affected must be sent to the Minister on or before September 30th. The objections must be in writing and must state the specific grounds of objection and the omissions, additions or modifications asked for. Objections should be addressed to the Ministry of Labour, 8, St. James's Square, London, S.W.1.

The Public Control of Industry

As a supplement to its General Council's annual report, the Trades Union Congress has just issued a document dealing with the public control of industry. It states that, in the last five years, public control has been attempted by three main methods, namely, public ownership; direct or indirect controls over the policy of private industry as regards the use of materials, prices, investment, &c.; and public supervision of private industry's own efforts to improve itself. The extent to which one or the other is used, the report observes, must depend on its demonstrated effectiveness and on the circumstances of particular industries. It is therefore agreed that public ownership should not be adopted simply for the sake of public ownership, "but only if it is thought to be the best way of doing the job." One of the conclusions set out in the document is that there is still a great deal to be done to improve the structure and operation of the publicly-owned industries, and, the T.U.C. says, "common sense indicates that at the present time efforts should be concentrated on making such improvements." As regards further nationalisation, it is claimed that the most important consideration in the short run is perhaps that publicly-owned industries will give the Government a greater leverage over the level of investment in the event of a depression. The T.U.C.'s view, however, is that public or common ownership need not always take the form of the nationalisation of whole industries. This report suggests that there is important scope for selective or competitive public enterprise and for the encouragement of co-operation.

Defence

By SIR ALFRED HERBERT K.B.E.

EVENTS in Korea, deplorable as they are, have at least caused us to wake up and rub our eyes. After each of the two last World Wars, we decided, as indeed is our custom, that we could settle down quietly to cultivate our gardens without worrying about the possibility, which rapidly became the probability and is now the certainty, of having once more to prepare our defences.

Our American friends have the atomic bomb, the existence of which we regarded as a sufficient threat to keep all wrong-doers in order, like the cane hanging on the wall in the old-world school room. We have never been told whether with all our atomic establishments we have actually produced an atomic bomb of our own, and although we had our first warning that other countries were making progress, when an atomic explosion was detected somewhere in the East, we appear to have disregarded the portent.

Those of us who recall, as I do, the deplorable shortages of munitions (in the widest sense of that word) which confronted us both in 1914 and 1939 must realise that our relative position is a good deal worse to-day. Before the outbreak of the two former wars we had great financial resources in our foreign investments, which no longer exist, and in the fact that our taxation was at a comparatively low level, so that by increasing it to the limit a large and immediate addition to our revenue was achieved. Nor must we forget the invaluable help we received from America under Lease/Lend and other forms of assistance.

To-day we have no foreign investments to realise and there is little scope to make any serious addition to our revenue from taxation, which is practically at war level. During the interval of uneasy peace we have been recklessly expending our resources in establishing the "Welfare State" with scant regard to the number of "Warfare States" which have been growing up around us with constant and increasing menace to our existence. Nor have we by any means removed the curse of inflation, which is glaringly obvious in every direction.

Unhappy as our finances are, our immediate difficulties are much more acute in regard to manpower. In both of our past emergencies, there were considerable numbers of unemployed both men and women, who were rapidly brought into our war industries. To-day there is practically full employment, both of men and of women, though thousands of both are still employed in Government jobs, which are in no sense productive, and which, in fact, frequently represent so many hindrances to production. Many of these people should be released for essential work.

Our position regarding industrial plant has greatly improved as large additions have been made during recent years, but owing to reduced working hours and lack of available labour, much of this plant is idle not only at week-ends, but at night; indeed, satisfactory night-shifts are almost non-existent. Recruiting for the Services and the recall of Reservists will still further limit the manpower available for industry.

Here are some suggestions as to certain courses of action, many of which are no doubt unpopular, but none of which can be entirely ignored in the critical situation which confronts us:

(1) In the present uneasy balance of the parties (as regards numbers) real progress and resolute action seem impossible. A Coalition Government would completely change the atmosphere; it would demonstrate to ourselves, to our Allies and to potential aggressors alike that we are united and in earnest. It would save endless unproductive controversy; it would make available for ministerial and executive offices the best brains of all parties and it would enable the Government to frame its policy without having continually to consider its effects on the party vote.

(2) To meet the imperative demand for war material many of our industries must obviously reduce their peacetime production and turn over to Government work. This will involve, of course, corresponding reduction in our exports, but however regrettable it is clear that this must be faced.

(3) In order to make more labour available for essential work, many of our present plans should be suspended or scrapped, including our extravagant preparations for the Festival of Britain, and all building not directly related to defence.

(4) By reverting to fourteen years as the school-leaving age, we could make many thousands of young people immediately available for industrial work, in which, with very brief instruction, they could render invaluable service.

(5) We should remove immediately, as we did so tardily in the last war, all restrictions on the employment of young persons and women on night-shifts.

(6) We should make all strikes illegal and definitely freeze all wages and prices.

(7) By reverting to a five-and-a-half or even a six-day week and by building up effective night-shifts, our present rate of output could be increased probably by 25 to 30 per cent, for not only would the machine-hours worked be greater, but the sense of urgency, which this action would produce, would inevitably lead to greater working efficiency.

(8) As regards machine tools, the shortage of which was our first handicap in previous emergencies, I believe the position is somewhat less acute, but the turnover in industry from peacetime to war work, particularly in engineering, would lead to a great demand for retooling of existing plants and for the provision of large numbers of "balancing" machines, and this work should have priority over all other commitments.

(9) Regarding measures of defence against aerial attack, even partially effective protection against the atom bomb would involve such lengthy preparations and the use of so much concrete and other material as to make it impossible for any rapid progress to be made. But if we are attacked from the air it is probable that most of the weapons used against us will be high-explosive bombs, guided missiles and incendiaries. Against these, trenches and other shelters as provided in the last war give a great measure of protection.

(10) The heaviest attacks would be directed against industrial centres, our most thickly populated areas and our ports. Gas and bacteriological warfare cannot be ruled out, for there is no limit to the ruthlessness of modern scientific devilment. Masks and protective clothing will certainly be required.

(11) The Home Guard should be reconstituted and re-armed, as parachute attacks are to be expected. Recruiting for Civil Defence should proceed apace and our fire brigades and ambulance services should be brought up to full strength.

(12) Plans should be prepared for evacuation, particularly of children, and here our past experience should provide invaluable guidance.

(13) Sabotage, which is mass murder, should be made a capital offence.

(14) Finally, all known Communists should be deprived of their present liberty and licence, all subversive meetings should be banned and Communistic journals suppressed.

We can no longer hide our heads in the sand. Danger is reduced by facing it. Time is short, and, to quote a hackneyed, but very sound, proverb, "It is later than we think," and as I look back over three-quarters of a century, it seems that with us it always has been.

Some American Locomotives and their Running

By W. A. TUPLIN, D.Sc., M.I.Mech.E.

No. III—*(Continued from page 175, August 18th)*

Milwaukee to Chicago

ON the journey from Milwaukee to Chicago the engine was handled by A. Raschke (engineer) and A. Shallow (fireman), and the Milwaukee Division master mechanic, Mr. W. W. Bates, also rode on the footplate as far as a special stop made at Wadsworth, 42 miles from Milwaukee. As the cab contains four seats, there was no need for anyone to stand, but the writer did so when making pencil notes in order to improve their legibility.

A four-coupled locomotive is a rarity on any important American train, but in this case the adhesion weight of 62½ tons was ample for the seven-coach train, and No. 3 got away from rest quite rapidly with only a momentary slip and with the steam chest pressure gauge indicating the full boiler pressure of 300 lb. With exhaust blasts plainly audible through the fire-hole, the exhaust pressure gauge showed little more than 15 lb per square inch at any time, and as the engine was "notched up" with rise in speed, the exhaust pressure dropped and the beat became inaudible. During the later part of the period of acceleration a knock could be felt at the end of each piston stroke, but when speed had reached 50 m.p.h. the throttle was partly closed, bringing steam chest pressure down to 200 lb per square inch, and the knocking ceased.

Over the first few miles from Milwaukee the gradients are adverse, including a length at 1 in 100, and the distance of 7·1 miles to Lake occupied 11 min 45 sec against a booked time of 10 min; but the engine then maintained an average of 78 m.p.h. to the stop at Sturtevant, 23·2 miles, reached in 24 min 9 sec from the start. The timetable allows 27 min to the re-start.

While the train was running in the open

country the engineer and fireman exchanged their readings of the track signals by hand motions, this being easier than by word of mouth across the width of the cab in the noise at high speed. The cab signalling apparatus provided confirmation that was hardly necessary in clear weather, but it disgraced itself after leaving Sturtevant by consistently showing red regardless of signal aspects. Misbehaviour of this sort is evidently not uncommon as the working timetable defines the procedure to be adopted when it occurs and so the train was stopped at Wadsworth, the first point at which there is a telegraph office. The start from Sturtevant had been made with 300 lb per square inch in the steam chest and when full speed of 85 m.p.h. had been reached the steam chest pressure was 220 lb and the exhaust pressure 5 lb per square inch. The distance of 19·1 miles was covered in 17 min 32 sec start to stop, with a maximum of 85 m.p.h.

From Wadsworth station a message was sent to inform the train despatcher that the cab signalling apparatus on locomotive No. 3 was known to be out of order, and in a very short time authority was received for the engineer to ignore it and to proceed as permitted by the aspects of the wayside signals.

The engine was re-started with steam chest pressure at 300 lb per square inch and a wider throttle opening was maintained than before with the result that the steam chest pressure had not fallen below 250 lb per square inch before Rondout, over 10 miles from Wadsworth, where the engine was eased over the crossing from a maximum of 88 m.p.h. Full throttle opening was then used, giving steam chest and exhaust pressures of 300 lb and 12 lb, reduced to 220/7 at West Lake Forest and to 200/5 from Deerfield to Glenview, after which a few miles were run with 250/7 before speed was reduced to 70 m.p.h. for the rail crossings at Mayfair. The 22·1 miles from Rondout to Forest Glen were covered in 14 min 54 sec at an average of 89 m.p.h., with a maximum of 92. The 32·7 miles from the Wadsworth start to the passing of Forest Glen had occupied 26 min 4 sec, but speed did not rise appreciably from the 70 m.p.h. over the Mayfair crossings and was reduced for the Western Avenue curve and crossings. Then the engine was opened out sharply with steam chest pressure at 270 lb for a short distance, but gentle running down the final incline and the crawl that is characteristic of the entry of trains into many large American stations caused the last 2·9 miles to occupy as much as 7½ min, although even this represents a substantial curtailment of the 10 min allowed by the working timetable.

The total running time of 82 min 11 sec was about the same as booked, assuming the stop at Sturtevant to last for 3 min, but the unscheduled stop at Wadsworth cost about 4 min running time. Omission of the Sturtevant stop would afford a further 4 min gain; subtraction of 8 min from the actual running time of 82 min shows that the engine could maintain the 75 min booking of the non-stop trains over the 85 miles between Milwaukee and Chicago. When these 4–4–2s were first set to work it was not uncommon for them to reach speeds up to about 105 m.p.h.; it is said that they could touch 110 m.p.h., but the writer knows of no accurate timing that confirms such a high figure.

The riding of this steam locomotive was quite as comfortable as that of the diesel-electric locomotive on which the preceding journey in the opposite direction was made. On the footplate no vertical vibration or rolling was perceptible and there was only the merest suspicion of yawing on curves. British "Atlantics" have a reputation for rough riding (and in one noted case the design makes it inevitable), but the longer wheel base of the Milwaukee "Atlantic" is, no doubt, a factor that contributes to its remarkably steady running.

(2) *Pennsylvania Railroad.*—Shortly after he had completed his footplate journeys from Chicago to Milwaukee and back the writer was royally entertained at the Union Station by Mr. J. P. Newell, General Manager of the Western Region of the Pennsylvania Railroad, and Mr. H. C. Wright, General Superintendent of Motive Power, before commencing a round trip to Fort Wayne, Indiana. This length of 148 miles is the first stage of the Pennsylvania's main line from Chicago to New York and, in conjunction with the additional 132 miles from Fort Wayne to Crestline, is the section on which most of the Pennsylvania's speed records have been made.

For many years the "K4s" class of "Pacific" locomotive (Fig. 5) was the pride of the Pennsylvania passenger train services. It was introduced in 1914 and built in considerable numbers at various times till 1932, when a modified version, classed as "K5," appeared. The "K4s" design is characterised by rugged simplicity and ability to stand up to the punishment imposed by the most ruthless engineer in regaining lost time with heavy trains. Its reputation in this respect is unexcelled in all America, where an unbreakable quality has long been regarded as essential in a locomotive. It met all Pennsylvania demands until about 1934, when the combination of fast schedules and heavy loads had begun to overmaster it and double-heading became a regular practice on the hardest duties. In 1939 the first move was made to develop a much more powerful Pennsylvania locomotive than the "K4s" and this materialised after collaboration between the P.R.R. and the three main American locomotive manufacturers as the "S1" class 6–4–4–6 locomotive No. 6100, that was exhibited at the New York World's Fair in that year. This engine was designed to haul 1200 tons at 100 m.p.h. on level track and it went into service on the Chicago-Crestline section in 1940. Experience showed that something not quite so large would be adequate for the heaviest passenger duties and might be designed also to operate over certain divisions on which the "S1" was prohibited by length or weight. This led to the design of a 4–4–4–4 locomotive, of which two examples were tried out in service; experience suggested the desirability of certain detail modifications incorporated in the present "T1" class, (Fig. 6) numbering fifty engines.

The design is basically a 4–8–4, but the coupled wheels are divided into two groups, each driven by two cylinders of small dimensions by American standards. Steam distribution to the cylinders is effected by poppet valves, two (5in dia.) for admission and two (6in dia.) for exhaust at each end of each cylinder. Duplication of valves is adopted because the capacity of a poppet valve is measured by the product of circumference and lift. For a given lift, two 6in diameter valves are equivalent to one 12in diameter valve, but the latter involves a greater clearance volume than is necessarily associated with a pair of 6in valves.

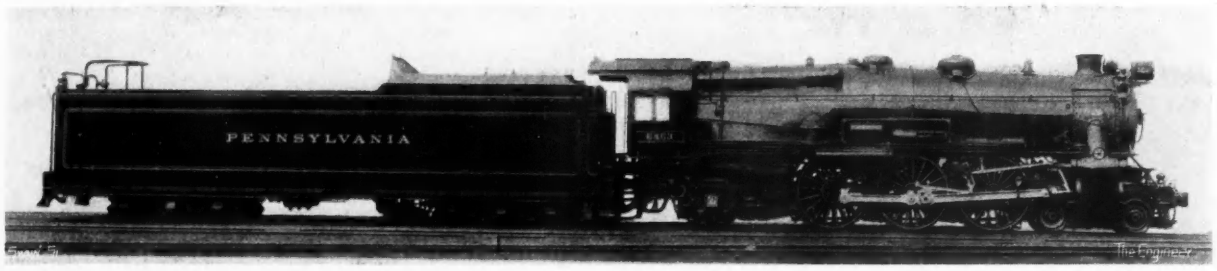


FIG. 5—PENNSYLVANIA RAILROAD 4–6–2 PASSENGER LOCOMOTIVE CLASS K4s

The double-beat poppet valves are cam-operated on the Franklin system. For each pair of cylinders there is a central box containing four sets of Walschaerts gear, each taking motion from two input shafts rocked by the crossheads through levers and links. Two sets of gear give motion to camshafts that operate the inlet valves on the two cylinders; the other sets control exhaust valves. The cut-off setting mechanism is designed so as to give later release and later compression at an early cut-off than would be practicable with a one-piece valve controlling both inlet and exhaust. The components in the central box are much smaller than the corresponding parts of conventional valve gear, but there are many pin joints and, despite the great advantage of dirt-proof and oiltight enclosure, wear eventually develops and may have a marked effect on the operation of the gear. Although the greatest advantage of independently operated exhaust valves can be expected only at early cut-off, that condition cannot in any case be used in an American locomotive developing its full boiler power, because of the relatively small cylinders or, to express the point accurately, because of the high ratio of actual tractive effort to nominal tractive effort. It is understood that one of the "T1s" is to be fitted with piston valves.

The "T1," although smaller than the "S1," weighs 220 tons and is well matched by its sixteen-wheel tender, weighing 193 tons fully loaded. In their early days engines of this class were most enthusiastically driven with the fast trains and the speedometer needle was frequently pressed against the

pin at 110 m.p.h., but this meant very hard running, which the "T1" does not accept with the same indifference as a "K4s" and it was found advisable to work within the known capacity of the engines rather than to aim at surpassing it.

It is the practice of the Pennsylvania Railroad and of the English G.W.R. to provide a member of the staff to accompany any stranger on the footplate, and within the cab of any large American locomotive there is ample room for two persons besides the crew. In fact, with mechanical stoking, which enables the fireman to remain in his seat, half-a-dozen extra people could find standing-room without obstructing the operation of the engine.

Chicago to Fort Wayne

On the outward journey, engineer and fireman were father and son, A. S. and A. A. Ayres, of Fort Wayne, while Road Foreman of Engines, W. C. Shoner, also of Fort Wayne, was an indefatigable guide, counsellor and friend for the other three footplate riders. The engine was "T1" No. 5528, in the not specially clean state that is normal alike in the U.S.A. and Britain at the present time, and a glance at the vast areas of sheeting on locomotive and tender impressed one with the fact that the cleaning of a large American engine demands considerable time and labour.

It is scarcely possible to obtain a really comprehensive view of a "T1" standing at a platform in an American station as the engine-and-tender length of 123ft requires an undistorted viewpoint to be about 400ft away and so much clear space is not usually available. (A similar problem with a linear magnification of 8 confronts would-be viewers of the "Queen Elizabeth" at a dockside.)

The train was No. 70 ("The Admiral"), leaving Chicago at 2.30 p.m. for New York, and it consisted of sixteen vehicles with a probable total weight of 1000 tons, which meant that even No. 5528, big as she is, was to pull about five-and-a-half times her own weight. A few minutes before starting time the H.T. type mechanical stoker was set to feed slowly and the blower started in order to minimise smoke.

It was stated that although the "T1s" were worked at 20 to 25 per cent cut-off in their early days, this was found to be impracticable when the engine was approaching the "run down" condition and that present practice is to use no cut-off lower than about 40 per cent, as shown on the quadrant. The relation between indicated cut-off and actual cut-off with valves controlled by cams, springs and a rather intricate mechanism in worn condition is apt to be uncertain.

The start from the Union Station was unhurried and for the first mile or so speed was low over various junctions and level-crossings. Nowhere on the 7-mile run to Englewood did the speed exceed about 50 m.p.h., and the time taken was 15½ min, as against the public timetable allowance of 15 min to the restart. On this length, vertical vibration was noticeable at the cab-end of the locomotive, giving uneasy forebodings of what might be expected at the higher speeds required between Englewood and Fort Wayne, but the effect was found to be purely local. It was noticed in the same vicinity on the return journey, but nowhere else, and the general riding of the engine was equal to that of a rather rough coach, although the cab was rather noisy at the highest speeds.

In starting from Englewood, the engine was opened out more rapidly than from Chicago and the somewhat "tinny" exhaust beat, similar to that of locomotives with Kylchap blast pipes, was heard through the open roof ventilator but not through the firehole. This departure from normal British experience is possibly associated with the use of a large smokebox with the baffles and spark-arresting netting common in American locomotives. The throttle was never fully opened and adjustment of cut-off from the starting maximum to the running figure of about 40 per cent was made in steps each accompanied by a hoarse shriek from the air-motor.

For a mile or so beyond Englewood "The Admiral" ran alongside the New York Central "New England States" train, booked to leave Chicago (La Salle St.) at 2.30 p.m., and Englewood at 2.44 p.m., on its way to Boston (Mass.). The normally gay and friendly attitude of American train crews and indeed of American people in general was well demonstrated here, as the enginemen on No. 5528 exchanged hand-waves and signals of encouragement with those on the competing diesel-electric locomotive and with Pullman staff on the other train. Even after this special stimulation had ceased at the parting of the ways, the engineer seemed to wave a hand to every visible person near enough to recognise the gesture, and drew an answering wave from everyone except the primmer varieties of female.

Speed had risen to 70 m.p.h. before Whiting (9·8 miles) but was reduced by brakes to 50 m.p.h. there and at Gary, 8 miles further on, and had risen to 70 m.p.h. at Hobart, 26·1 miles from Englewood. From passing Hobart to passing Junction, just before Fort Wayne, the distance of 113·5 miles was covered in 91 min 45 sec at an average of 74·3 m.p.h. and this included a reduction to 57 m.p.h. over the water-trough between Hanna and Hamlet. The speedometer never fully opened and adjustment of cut-off from the starting maximum to the running figure of about 40 per cent was made in steps each accompanied by a hoarse shriek from the air-motor.

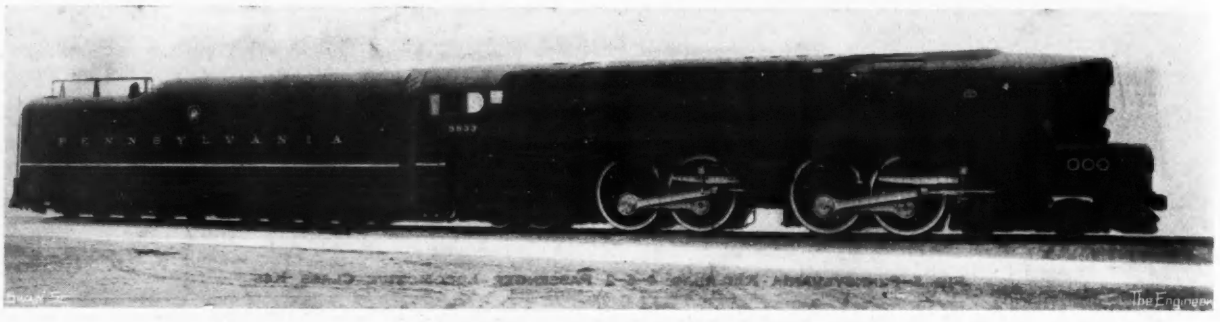


FIG. 6—PENNSYLVANIA RAILROAD 4–4–4–4 PASSENGER LOCOMOTIVE CLASS T.1

TABLE II.—*Pennsylvania Railroad*

Direction	Down	Up
Train number	70	53
Number of vehicles	16	6
Approximate tonnage	1000	400
Class of locomotive	"T1"	"T1"
Wheel arrangement	4–4–4–4	4–4–4–4
Locomotive number	5528	5527

Timing point	Miles	Minutes	Speed (m.p.h.) Inter.	Speed (m.p.h.) S. to s.	Miles	Minutes	Speed (m.p.h.) Inter.	Speed (m.p.h.) S to s.
Englewood	0	0			18·0	20·75	52·0	52·0
South Chicago	5·5	7·33	45·0		12·5	—	—	
Indiana Harbour	12·9	14·83	59·2		5·1	—	—	
Gary	18·0	19·45	66·3		18·6	19·63	54·7	56·9
Hobart	26·1	28·0	56·9		10·5	10·75	78·0	
Wheeler	30·0	31·33	70·2		6·6	7·75	51·1	
Valparaiso	36·6	37·25	67·0		65·1	56·75	65·3	68·8
Wanatah	45·8	45·00	71·3		55·9	48·30	65·7	
Hanna	52·1	49·67	81·0		49·6	42·55	69·2	
Hamlet	62·5	58·88	67·6*		39·2	33·55	74·8	
Donaldson	69·9	65·33	68·8		31·8	27·58	71·0	
Plymouth	76·8	71·25	71·0		24·9	21·75	68·6	
Inwood	82·9	75·92	78·5		18·8	—	—	
Bourbon	87·6	79·50	78·9		14·1	—	—	
Attwood	95·2	85·08	81·7		6·5	—	—	
Warsaw	101·7	89·78	83·0		39·3	34·63	62·0	68·0
Pierceton	110·1	96·32	77·1		30·9	26·50	80·5	
Larwill	114·5	100·00	71·7		26·5	23·22	77·3	
Vandale	121·5	105·18	79·2		19·5	—	—	
Arcola	132·6	113·25	75·5		8·4	9·17	55·0	
Fort Wayne	141·0	122·67	53·5	69·0	0	0	—	

* Including reduced speed over water trough

Owing to the writer's lack of previous acquaintance with the route, he had some indicated a maximum of 90 m.p.h. between Bourbon and Attwood and again beyond Vandale, but it was reading somewhat high and the actual maximum was nearer to 87 m.p.h.

difficulty in locating stations for timing purposes and formed the opinion that to do justice to an occasion of this sort whilst leaving the observer on the footplate free to record happenings there in a reasonably leisurely manner, a second observer familiar with the road should ride in the train to take passing times at stations and mile-posts. An American wayside station is a single building of modest proportions unmarked by signals or platforms, and it does not stand out from other buildings in its vicinity. Consequently it is not easy for a strange observer to sort out the station from a town passed at 80 m.p.h. and one or two passing times recorded on this trip seemed, on later examination, to refer to some building other than the intended station, and were therefore rejected. Mile-posts could be seen without difficulty and several readings taken from them with a split-second chronograph confirmed that the speedometer readings were in general higher than the truth. Owing to the great height of the footplate above rail-level, there was little sensation of high speed except when passing close to buildings, bridge abutments or trees.

On this fast run over a generally straight route with slight undulations through agricultural country of average British character, the position light signals were seen a mile or so before they were reached but they were not read with certainty at more than about three-quarters of a mile. Level crossings are fairly numerous and so the engineer's left hand was continually seeking the whistle-chain.

In the early part of the journey the boiler pressure was maintained between 275 lb and 300 lb per square inch but near to the 50-mile point a pipe failed in the boiler feed pump system and recourse had to be made to the injector. This adversely affected the steaming of the boiler and pressure thereafter lay between 230 lb and 250 lb per square inch, with the blower in operation. With the feed pump out of action there was no reserve to cope with any possible failure of the injector and so a message was thrown out at a station for a locomotive to replace No. 5528 at Fort Wayne.

The control for the tender water-scoop is at the front of the tender at a point about 3ft behind the cab. The fireman works the control to lower and, later, to raise the scoop in response to shouts from the driver as the engine approaches the beginning and end of the trough.

Cut-off remained constant, but there were occasional changes in regulator opening to adjust the effort of the engine to the slight undulations of the road. The exhaust sound was barely noticeable for most of the running time, but when the engine was set to make an extra effort in climbing, there was a rasping rattle from the double chimney. The exhaust cloud was consistently dark, but it was not possible to ascertain whether any noticeable amount of smoke was being left behind.

Apart from the incident with the defective pipe and an occasional small change in throttle opening, the engine ran 100 miles without human intervention. Speed variation over this distance was small except for the reduction over a water trough and the running was uneventful, but the writer suffered no trace of monotony during this 90 min period as the scenery outside the cab was interesting enough to occupy the attention in the brief intervals between recording figures and notes about the running of the locomotive.

Beyond Arcola the throttle was almost closed, the train brake applied and then the engine's "straight-air" brake controlled by a separate handle. This procedure with the brakes is apparently not uncommon, although for passenger trains it does not carry official approval, which is in favour of using the connection that causes the locomotive brake to be applied simultaneously with the train brake and to the proportionate extent.

Speed past Junction, 1·4 miles short of Fort Wayne, was low and it was kept down to a cautious figure in the final approach to Fort Wayne station, where a careful stop was made in 122 min 40 sec from Englewood, instead of the 126 min allowed, the average speed from the Englewood start having been 69 m.p.h. for 141 miles.

The average gradient from Englewood to Fort Wayne is 1 in 4000 up, but the summit point between Pierceton and Larwill is about 380ft higher than Englewood, giving an average adverse gradient of 1 in 1550 for 112 miles. The steepest gradient is 1 in 250 upwards to the east for about 3½ miles on each side of Donaldson. For 10 miles on each side of Larwill summit the gradient is 1 in 262.

At Fort Wayne, No. 5528 was detached from the train and went to the round-house, whilst another "T1" class locomotive took her place for the resumption of the journey eastward. The writer's "turn-round" time at Fort Wayne permitted a wash, a meal and an interesting discussion with Mr. Shoner about differences between locomotive operation in America and Britain. The return to the station was made at the right time to obtain a broadside view of the westbound train No. 53 ("The Fort Pitt") as it ran in behind another "T1," No. 5527. This afforded a memorable impression of the size of locomotive and tender, excessively large indeed for the train which was one of only six cars. (Normal loading is much heavier, but this was a Saturday evening.)

(To be continued)

Warragamba Dam

GEOLOGICAL INVESTIGATION AND PRELIMINARY WORKS

SINCE the inception, in 1888, of the Metropolitan Sewerage and Drainage Board as the controlling authority for the water and sewerage services of the Sydney metropolitan area and south coast towns in New South Wales, the population served by the Board has increased nearly sixfold, and now numbers about 1,800,000. In the same period the water consumption has increased over sixteenfold, the maximum demand now being 232 million gallons per day, and yearly consumption 47,925 million gallons. As the five existing major storage dams in the fully regulated Nepean and Woronora Catchment Areas, of 347 square miles and 29 square miles respectively, have only a total holding capacity of 122,000 million gallons and a safe draught of 92 million gallons per day, it has been apparent for many years that additional storage from another source must be provided.

Of all the streams available for water supply near the metropolis of Sydney, the Warragamba River, with its large catchment area of 3383 square miles, is the most important. It first attracted attention as far back as 1845, and in 1869 a proposal was put forward to build a rock-fill dam 170ft high across the Warragamba gorge to supply Sydney with water. Various representations have been made since that date to develop its resources and a number of alternatives investigated, but it was not until 1936, during a period of severe drought, that the first practical action was taken to harness the flow of the river. In that year the Board commenced the construction of the first stage, which was adopted as an emergency scheme, to supplement diminishing storages in its existing reservoirs. This first stage consisted of the construction of a concrete weir approximately 50ft high (crest level R.L. 90) and 220ft long across the Warragamba Gorge at a point slightly downstream of the proposed main dam, together with an underground pumping station equipped with six 1000 h.p. motors and 24in centrifugal pumps and a 48in diameter steel pipe-line 16 miles long, having a capacity of 40 million gallons per day.

On completion of this work in 1940 attention was given to commencing the second and third stages, consisting of the construction of an 84in diameter pipe-line parallel to the 48in diameter line, and the main dam respectively. Completion of the 84in diameter line will enable the supply from the pumping station to be more than doubled, but continued shortage of steel, both during the war and the years subsequent to the war, has so far prevented this line from being completed and put into operation. Some preliminary work was also carried out on the third stage during the war period, and has been greatly accelerated since the cessation of hostilities.

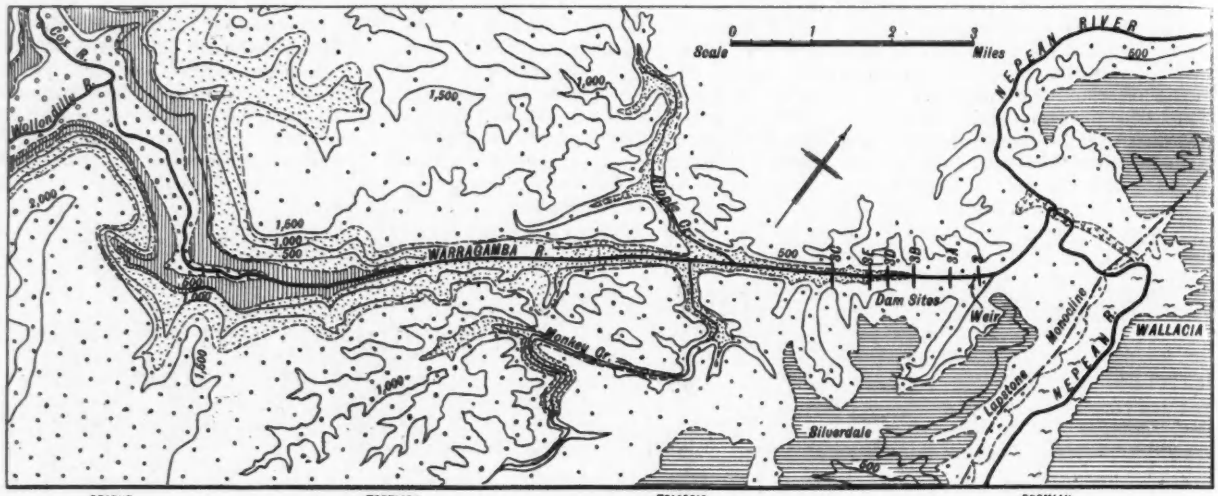
The proposed dam will be a straight gravity mass concrete wall, constructed by pouring concrete in 50ft by 50ft columns, which will be subsequently grouted together to form a monolith. Its overall length will be approximately 1300ft, with a central spillway section 290ft long at a crest level of R.L. 383. The abutment sections will rise to a level of R.L. 434 to enable the spillway to cope with the estimated maximum flood of 500,000 cusecs. Foundation level is expected to be about R.L. 20 and the total concrete to be placed about 1½ million cubic yards. Three 84in diameter outlets will be situated at R.L. 181 and will merge into two 106in diameter delivery mains immediately downstream from the dam. Provision is also being made for a low level 84in diameter outlet at R.L. 76·5 for conveying water to the emergency scheme pumping station during the early stages of construction. The holding capacity of the dam will be 460,000 million gallons, with a net safe draught of 263 million gallons per day.

Geological Investigations

Detailed geological investigations were commenced in the Warragamba Area in 1944. Previously, because of the rugged and undeveloped nature of the country the geology was known only in very broad outline. For a considerable part of the time the investigations by the Board were guided by Mr. L. L. Waterhouse, B.E., and Dr. W. R. Browne, from the Geology Department, Sydney University, who acted as consultants.

The Warragamba River is the name given to the stream formed by the confluence of

the Wollondilly and Cox's rivers, and flowing for 14 miles downstream, to where it joins the Nepean River, near the village of Wallacia. For three miles in a general easterly direction, it flows in a wide valley, narrowing downstream, with gently sloping lower sides capped with high sandstone cliffs. It then turns sharply and enters a precipitous gorge in which it flows in a general north-easterly direction, through the barren sandstone Blue Mountains Plateau for the rest of its course. For 10 miles the gorge is remarkably straight, as may be seen from the illustration above, which shows the geological formation of the region.



GEOLOGICAL PLAN OF THE WARRAGAMBA AREA

The rocks are principally sandstone and shale of Triassic and Permian Age. The only igneous rocks are basalt and breccia of Tertiary Age, in a volcanic neck at the junction of the Warragamba with the Nepean River. The Triassic strata are all of fresh-water origin and have been divided into three series. The youngest of these, the Wianamatta Series, consists chiefly of shales, which occur only as thin residuals on the plateau surface. The Hawkesbury Series (intermediate in age) consists of about 500ft of coarse and fine current-bedded sandstones, with occasional lenticular beds of shale, usually somewhat carbonaceous. The Narrabeen Series (the oldest) is about 1000ft in thickness and consists mainly of sandstones and shales. The sandstones are principally fine-grained and the shales are more abundant than in the Hawkesbury Series. In general, bedding planes are developed throughout both Series, of very variable spacing—from a few inches to many feet—sometimes indicated by very thin shale or clay partings. The Triassic rocks rest upon Permian Upper Coal Measures consisting of 400ft of sandstones, shales and coal seams, which overlie Upper Marine conglomerates.

All of these strata are conformable and have a general dip towards the east of 1 deg. to 2 deg.; but about 1 mile west of Wallacia they are folded down steeply to the east, showing dips up to about 40 deg., forming a structure known as the Lapstone Monocline. This structure has a meridional trend and has been traced for many miles. The monoclinal fold carries the Hawkesbury sandstone down below sea-level and forms a pronounced escarpment separating the low-lying, undulating plain occupied by about 40ft to 140ft above sea-level. As a consequence the river-bed followed upstream exposes successively older rocks. The gorge is formed mainly of jointed, hard, resistant Hawkesbury and Narrabeen sandstones, which crop out as vertical cliffs separated by benches of variable width formed by weathering of shale bands. The river valley is wider where the stream has cut down to the softer, more easily eroded Coal Measures and Upper Marine conglomerates. The greater part of the storage of the reservoir will be in the wide valleys of the Cox's and the Wollondilly upstream of the commencement of the Warragamba.

The straight, 10 mile section of the gorge is related to another structure, an anticlinal fold developed in both Permian and Triassic rocks, which strikes north-easterly and gradually dies out downstream. The river evidently developed in the fractured rocks along the crest of this fold. Associated with the fold there is probably also some faulting along the line of the river. The strata are here traversed by a strong set of subvertical joints striking parallel to the river and a less pronounced set of cross joints. Adjacent to the northerly trending Lapstone Monocline the principal joint direction is north-south; movement has taken place along some of these cracks.

The presence of these two unfavourable structures—the anticline upstream and the monocline downstream—led the geologists to consider that the most favourable section of the gorge for a satisfactory dam site was about 2 miles in length, mostly upstream of the existing diversion weir. In this distance the many small creeks draining into the river from either bank reduced the number of possible dam sites to six, known as sites 3, 3A, 3B, 3D, 3E and 3C. These sites have been investigated by diamond drilling supplemented in some cases by 48in diameter shafts drilled by shot drills. Sites 3 and 3A adjacent to the weir and existing services, were the first to be tested. As a result of rather intensive investigation at these places, it was considered that a more suitable site might be found further upstream. Scout drilling was then undertaken at the other sites and as a result the present position, at site 3B, was selected.

The drilling at sites 3 and 3A showed that while the strata as a whole were substantially impermeable, groundwater circulated freely in open subvertical joints and fractures and to some extent along bedding planes. As a consequence the upper surfaces of shale beds as far down as 65ft below river-bed level were found to be generally thoroughly pugged and converted into clay. Such clay would be liable to decrease in thickness under the weight of a dam and would provide a sliding surface. At site 3 a lenticular shale-bed, 25ft thick and 65ft below river-bed level had up to 1ft of clay on its upper surface, with some on its lower surface as well; certain bores showed diagonal cracking towards the base of the shale, with some evidence of movement along cracks.

Subsequent drilling, therefore, was directed chiefly towards finding a sandstone bed free from shale in the foundation zone, in the remaining section of the river, which, on surface indications, was not obviously affected by the monocline and anticline. Such a bed was found at site 3B, with its upper surface at about 20ft above sea-level, that is, 20ft below river-bed level and dipping downstream at a small angle, between 1 deg. and 2 deg. Further upstream this bed was split by shale seams. Downstream it had previously been noted at site 3A, but was there 60ft below river-bed level.

Site 3B was therefore adopted as the most suitable site for a high concrete gravity dam. Intensive drilling was then undertaken to investigate the detailed structures at this site, a cross section of which is shown on page 201.

The foundation bed consists of about 120ft of chiefly fine and medium-grained sandstone, which grades locally into coarse and pebbly phases. This rests on some 20ft of a very coarse sandstone and fine conglomerate, which in turn rests on a bed of red shale. This shale is not pugged and appears

to be quite sound. The sandstone is compact and impermeable, consisting of quartz grains set in an argillaceous and sideritic matrix. It has the physical properties shown in column A of the table.

	A	B
Strength in compression	3830 lb per square inch	5490 lb per square inch
Strength in shear ...	2030 lb per square inch	2520 lb per square inch
Young's modulus ...	$0{\cdot}49 \times 10^6$ lb per square inch	$1{\cdot}13 \times 10^6$ lb per square inch
Poisson's ratio ...	0·11	Not tested

Overlying this foundation bed is some 70ft of sandstone of variable texture with interbedded shale and shale breccias. These beds occurred downstream in the foundation zones of site 3 and 3A and to a large extent were responsible for the rejection of those places as dam sites. All of these beds belong to the Upper Stage of the Narrabeen Series. Overlying them are coarse and fine sandstone with lenticular shale beds belonging to the Hawkesbury Series.

The original water table, later raised by the building of the weir, was at about bed-level along the river, rising gradually under the banks. Above this level there is a marked change in the cementing material of much of the sandstone. The fine-grained impervious sandstones frequently retain much of their original argillaceous sideritic cement, but in the more abundant, coarser and more porous sandstones the cement is now chiefly secondary limonite, some kaolin and a good deal of secondary silica. These changes are reflected in a change in the physical properties of the sandstone, as shown in column B of the table.

The main foundation block will therefore rest on sandstone with rather different physical properties to that in the abutments, which factor creates some problems in design.

Exploratory Drilling

The drilling programme carried out in connection with the geological investigation was commenced with three diamond drills hired from the New South Wales Mines Department, producing cores approximately 3in in diameter. They were later supplemented by the purchase of a number of additional diamond drills, giving cores $1\frac{5}{16}$in in diameter.

Both types of drill are operated by compressed air at 80 lb pressure, and water at 40 lb surface pressure is necessary for the efficient cleansing of the hole. Each drill is operated by a crew of two men. Most of the exploratory holes drilled have been of the order of 250ft in depth, but occasional holes have been put down to a depth of 500ft.

Cores taken have normally been between 5ft and 10ft in length and are broken off by means of the insertion of coarse sand, which is washed past the core to the bottom of the hole, where it consolidates. Turning by hand then breaks off the core. Cores on removal are marked in terms of reduced levels, packed in wooden boxes and stored for future reference.

The information gained from the cores is visually collated on a pin model, on which each core is represented by a pin or dowel appropriately marked throughout to represent the nature of the different strata concerned. Each pin is fitted, correct to the scale of reduced level, into a hole in the baseboard corresponding to the scaled grid position of the respective bore-hole. By this means the main features of the geological strata of the area are represented.

The total amount of exploratory diamond drilling carried out on the several sites considered exceeded 46,000ft, by the end of 1949 including nearly 19,000ft on the site selected. Further detailed exploratory drilling is continuing on the final site in combination with drilling for grouting purposes.

In addition to the diamond drilling two drilling machines, giving 45in diameter cores, were hired from the Water Conservation and Irrigation Commission. These machines operate with No. 7 to 8 chilled shot and are provided with sufficient rods to enable drilling to be taken down to a depth of 200ft. Cores are broken off by small charges of gelignite at approximately 6ft intervals and are removed by a specially designed core lifter. On removal the cores are marked and transported to the core depot, where they are laid out on the ground in sequence for detailed examination by the geologist. It was found essential to have the coring barrel commence drilling in solid level material and, if this was not obtained as a result of boring the rock at the site, a level starting surface was made up with concrete. The speed of rotation when drilling is about 60 r.p.m. and the average rate of progress during actual drilling about 6in per hour, but has varied between $\frac{1}{2}$in per hour and 30in per hour, according to the nature of the sandstone encountered. Similarly, the amount of shot used is usually between 6 lb to 10 lb per foot of drilling, but has been as low as 1 lb per foot of drilling in very soft sandstone.

The most difficult problem met during drilling was inflow of water through shattered ground, and rates of flow up to 27,000 gallons per hour had to be dealt with. This called for pumping in the first place, but when the flow could not be controlled recourse was made to grouting. On the other hand, grouting was liable to reduce the value of the hole from the geologist's point of view, as he naturally preferred to examine the defective ground in its natural state.

Sulphuretted hydrogen was often encountered and action had to be taken to circulate air throughout the hole in order to avoid injury to the operating personnel. The cutting edge of the boring barrel became worn during drilling operations, which necessitated attention about every 100ft by cutting about 2in off the worn edge.

Although the rate of actual drilling has already been mentioned, the overall rate is affected by the above-mentioned circumstances, and the situation with regard to two typical but contrasting holes is given in the second table in terms of percentage of time occupied under each item.

Under normal conditions a crew of three men is employed—a miner in charge of operations, an offsider, who remains at the surface throughout, and a driver for the drill. The total amount of drilling performed on the several sites by the end of the year was 2841ft, which included an amount of 899ft at the selected site 3B.

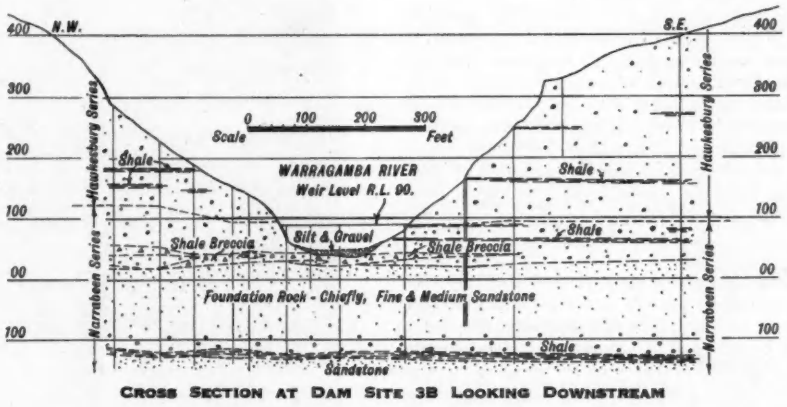
The results obtained from shot-drilling, in comparison with the limited information gained from diamond drilling, are accepted as being very satisfactory in that the large core enables a close and detailed examination to be carried out and the cross section of the hole permits access for the geologist and engineer, by means of a cage, to examine the exact rock conditions in situ throughout, and particularly to explore the nature of faults encountered.

	Per cent	Per cent
Actual drilling	10·5	28·0
Core lifting	26·5	25·0
Breakdowns and attention to plant...	20·0	9·0
Pumping	22·5	26·0
Grouting	20·5	12·0

Construction Programme

Having decided the site of the dam, the first requirements were the lay-out and construction of a township and the planning and development of the works area. The township is designed ultimately to accommodate a population of 3500 and will consist of 600 cottages for workmen with families, barracks for single men, a business centre, public buildings, schools, churches, administrative offices, cottages for married officers and quarters for single officers of both sexes. There will be an ample water supply and the township will be completely sewered.

The major preliminary work of diverting the river at the site of the dam consists essentially of an upstream and a downstream cofferdam in relationship to the dam site, combined with a concrete-lined diversion tunnel, approximately 1900ft long and 18ft by 14ft in cross section, driven in the eastern side of the gorge, to take a flood of 3600 cusecs.



Cross Section at Dam Site 3B Looking Downstream

Owing to the nature of the river bed and the liability to sudden, heavy floods, particular attention has been given to the design of the cofferdams.

The sloping faces will be constructed with gabions consisting of elongated heavy wire mesh baskets, each carrying about 5 cubic yards of sandstone spalls, placed in successive layers across the river-bed with the major axes lying in the direction of the river.

The space between the upstream and downstream gabion faces will be progressively filled with quarry refuse through which a

watertight membrane of steel sheet piling will finally be driven to engage in a previously excavated trench in the rock of the river-bed.

Construction methods during these operations are largely governed by the requirement that the supply of clear water to the pumping station of the emergency scheme must not be interrupted.

With regard to flood warnings, satisfactory experiments have been carried out and action is in hand to install an automatic wireless system to meet the situation, as other means of communication in vital parts of the area are practically impossible, due to the difficult country concerned.

Coarse aggregate, 6in and under, and fine aggregate for the concrete of the dam will be obtained from a large alluvial deposit, known as McCann's Island, in the Nepean River, near Penrith. After washing and screening at the Island, the material is to be conveyed a distance of 12¼ miles to the dam by a bi-cable ropeway, with a capacity of 170 tons per hour.

Full use will be made of modern earth-moving plant for dealing with 2¼ million tons of material to be handled at McCann's Island, also for excavation of the dam foundations and the removal of the resultant spoil to dumps.

Two cableways, of 1640ft span and 18·1 ton hook load capacity, and one of 1030ft span and 10-ton capacity are being installed to carry out the first task of removal of spoil from the excavations for the dam foundations, followed by the deposition of concrete for the main wall and apron.

The central mixing plant comprises four 2 cubic yard tilting mixers and automatic weigh batching equipment and has been designed for a peak output of 150 cubic yards per hour. Provision is being made for the inclusion of crushed ice in the added water when necessary, in order to keep the concrete within the prescribed temperature limit.

Similarly a cooling system of circulating water, involving refrigeration plant, will be adopted in the concrete of the dam to dissipate the heat of hydration.

A general plan for foundation grouting has been outlined, which will develop in detail as foundation excavations progress. The establishment of a grout curtain completely surrounding the area of the future excavations in the river bed and between R. Ls 55ft and 10ft will be kept well ahead of excavation work in order to seal off groundwater between these levels, which is deleterious to concrete.

This article was communicated by the Metropolitan Water, Sewerage and Drainage Board, Sydney, New South Wales, Australia. It is hoped to publish further articles describing subsequent stages of the work at a later date, when progress on the dam becomes more advanced.

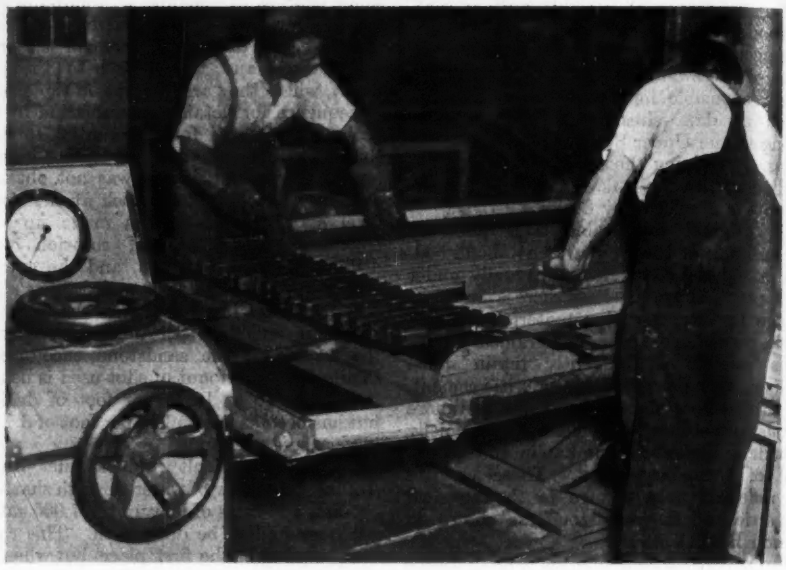
ALUMINIUM ALLOY CASTINGS.—The Aluminium Development Association, 33, Grosvenor Street, W.1, has published Information Bulletin No. 17, entitled "Aluminium Alloy Castings." Price 1s. It is intended to assist casting users to make the best use of the alloys and is well illustrated. Casting processes are described and also the equipment used, including such details as the life of patterns. The choice of casting method and of alloy is discussed and the influence examined of such factors as pressure tightness, fluidity and machineability. A guide to the selection of the right alloy is given in Appendix II. Some notes on casting design advise on what makes a good or bad casting and a final chapter touches upon the methods of inspection. Appendix I lists the various alloys together with related composition and properties.

Construction of Laminated Plastic Panels

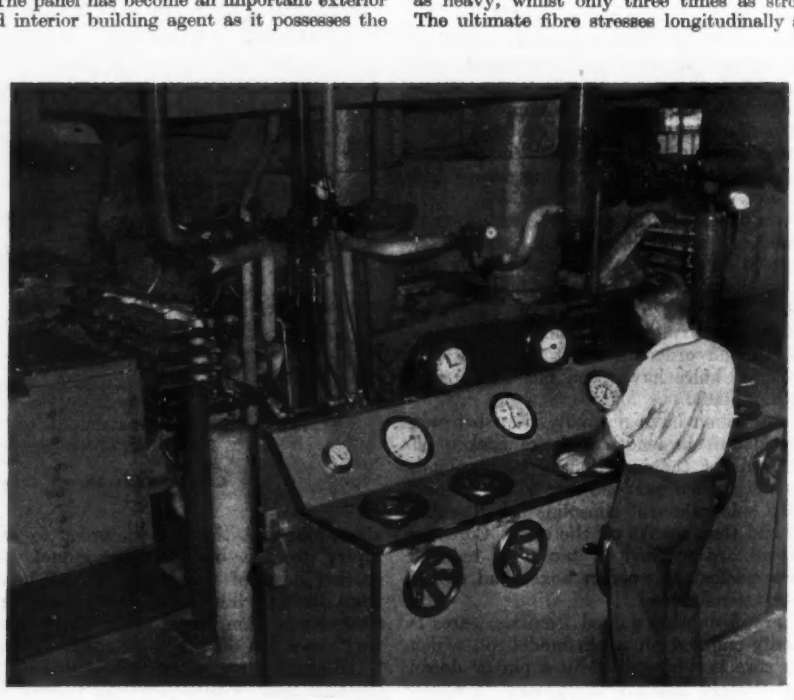
WE took advantage last week of an invitation to visit the works of Holoplast, Ltd., New Hythe, Maidstone, to see the manufacture of their laminated-plastic structural panel. The plant was designed to mass-produce these units for the specific purpose of bulkhead construction during the war, and until recently most of the production has been directed to the shipbuilding industry and to foreign markets.

The panel has become an important exterior and interior building agent as it possesses the unusual combination of structural, acoustic, thermal and weathering properties, together with a decorative finish if required. It is claimed by the makers to be the only structural panel of its kind in the world.

Each of these units is essentially a compounded panel of twenty-three "I" girders, 8ft long with continuous flanges, and a web spacing of 2in. The 8ft by 4ft flanges are 1⅛in thick and the ribs ⅛in thick. A smaller section is available. A panel unit is fabricated entirely from resin impregnated paper and weighs 2 lb per square foot. Consideration of its strength/weight ratio show that an equivalent mild steel section would be five times as heavy, whilst only three times as strong. The ultimate fibre stresses longitudinally and transversely are 12 tons and 54 tons per square inch respectively. The greatest moment of inertia is 0·605in⁴ per 12in width of panel, and the modulus of elasticity 2·1 by 10^6 lb per square inch. The panel is therefore quite



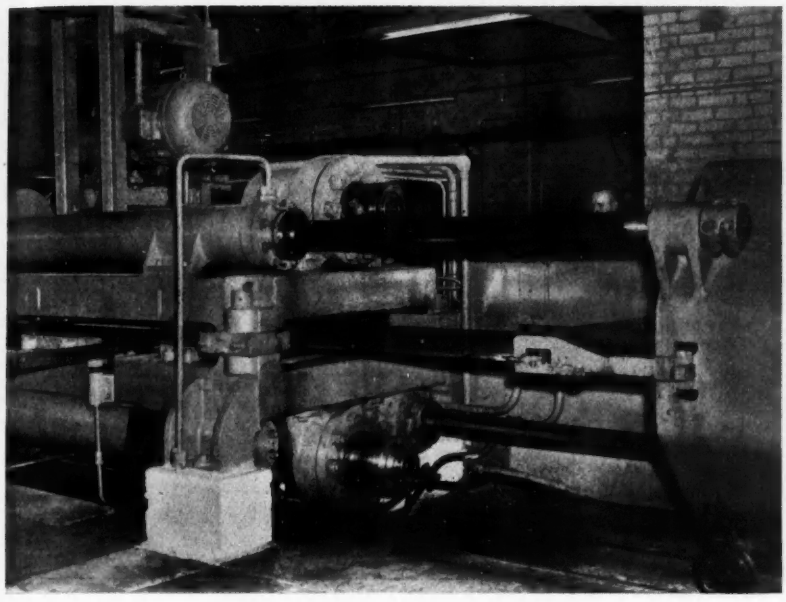
ASSEMBLING A PANEL



PANEL UNITS AND 3500-TON PRESS

rigid and under severe weathering tests remains dimensionally stable. The material does not support combustion or spread flame (British Standard Definition 476). It is said to be both impervious to vermin, insects and fungi growth, and unaffected by water, normal heat changes, most solvents, oils and dilute organic mineral acids.

The basic raw materials are kraft paper and phenol-formaldehyde water-soluble resin, and consequently the site was chosen adjacent to the factory where the paper is rolled and impregnated. The impregnated paper is supplied in sheets 110in by 56in, which form the flanges, and in rolls 2in wide.



MANDREL WITHDRAWING MACHINE

The first operation consists of forming the rectangular tubes, which ultimately become the ribs of the finished panel. These tubes are initially rolled without overlap from the 2in reels of impregnated paper. Two machines form circular tubes 8ft long with left-hand and right-hand spirals, which are needed to produce a panel of properly balanced construction. From the winding machines the tubes are fed directly into deforming machines, from which they emerge with a rectangular cross section.

The impregnated sheets, used to form one flange of the panel, are assembled on a base-plate and have twenty-three of the rectangular tubes, placed side by side, upon them, those with left-hand and right-hand spirals alternating. Two tapered rectangular mandrel bars are then inserted from opposite ends into each tube and positioned to give the correct final interior size. A panel in course of assembly can be seen in one of the photographs reproduced on page 202. A second set of sheets is then placed over the assembly and the pack clamped together in a jig. The pack assembly in its jig, which weighs approximately 2 tons, is then rolled on gravity conveyors to the charging unit in an adjacent shop. The charging unit is designed to take six complete assemblies, one above the other. This unit is raised and lowered hydraulically and from it the six assemblies can be introduced into six apertures in the 3500-ton hydraulic press illustrated herewith. During the loading operation a similar unit on the other side of the press receives six consolidated assemblies. The whole of the operation, which involves the simultaneous insertion and removal of approximately 12 tons of assemblies, takes about 90 seconds.

During the consolidating process the assemblies are subjected to a vertical pressure of 1500 lb per square inch and a horizontal pressure sufficient to support the mandrels in their separate tubes. The critical temperature at which this pressure is applied is obtained by the use of steam-heated platens between the six assemblies in the press. With this application of heat and pressure the separate layers of paper and the tubes are formed into a homogeneous, phenol-formaldehyde laminated structure. The platens are then water-cooled to facilitate the removal of the assemblies to the discharging unit. From the discharging unit the panels are transferred to a machine, shown in our illustration on this page, for withdrawing the mandrels or dimensioning bars. In this machine, which exerts a pull of 500 tons, the bars are automatically withdrawn in a pre-set sequence.

During the mandrel-withdrawing operation, the panels themselves are subjected to the full 500-ton load and this forms an effective test of their strength. In the final manufacturing operation the panels are trimmed in fully automatic dimensioning sawing machines to the finished size of 8ft by 4ft.

The panels may be finished in various ways. They may be pressed between either stainless steel or resilient top and bottom plates, to give a glossy or naturally mottled finish. If veneered panels are required, a wooden veneer previously mounted on paper and impregnated, is incorporated during the fabrication of the panel. Both glossy and mottled finish panels can be sprayed with a synthetic finish in a range of attractive colours. In this process the panels or boards are passed on a monorail conveyor through the spraying booths and finally through a 100kW infra-red drying oven, employing gold-plated reflectors. The high temperature to which the panels are exposed serves as a stringent test, which they must undergo without distortion.

The time taken to process one panel is approximately sixty minutes. The firm are now extending the plant with a view to doubling the present production.

At the time of our visit we were also shown a new type of corrugated sheeting which is now being produced from corrugated impregnated paper.

INDUSTRIAL GAS TURBINES.—The fortieth May lecture, entitled "Industrial Gas Turbines," delivered on May 10th by H. Roxbee Cox, Ph.D., to the Institute of Metals, has been reprinted, by the authority of the Council of that body, from the *Journal* of the Institute of Metals.

South African Electricity Supply Commission

THE twenty-seventh annual report of the South African Electricity Supply Commission shows that the programme of plant expansion entails capital expenditure for the next few years amounting to approximately £54,000,000, of which about £26,000,000 will be allocated to the provision of power for the Rand Undertaking, including the new goldfields of the Orange Free State.

The new station at Vierfontein, on a coalfield about 8 miles south of the Vaal River, which will serve the new goldfields will have an initial capacity of 150,000kW and an ultimate capacity of 210,000kW. The initial installation, which is expected to be in commission in 1953, will cost £7,000,000. The second new station (Taaibos), to serve the Orange Free State goldfields and industries, will have an initial capacity of 120,000kW and an ultimate capacity of 200,000kW. Its 60,000kW generators will be the largest in South Africa.

To supply the northern area of the Cape Western system and provide power for the electrification of the railway main line from Bellville to Touws River, a station is being built at Worcester, with an initial capacity of 60,000kW and an ultimate capacity of 100,000 kW. The initial installation is estimated to cost £3,600,000.

To meet increasing demands in the Durban area, a new station is being built near Pinetown, with an initial capacity of 60,000kW and an ultimate capacity of 240,000kW. The initial installation will cost £4,750,000.

To serve the Cape Town area a second power station is to be built at Salt River, with an initial capacity of 30,000kW and an ultimate capacity of 180,000kW. The final cost is estimated at £8,000,000. New power stations are also projected at East London and Port Elizabeth.

The Electricity Supply Commission in South Africa is a statutory body, which is expected to operate at neither a profit nor a loss. Its total revenue last year was £8,799,486 and its production costs totalled £8,820,887.

In 1949 the Commission sold 6,222,000,000 units, compared with 5,577,000,000 units in 1948. Average revenue per unit sold was 0·3049d., and average cost per unit was 0·3056d.

The cost of contracting and equipping new power stations will be very much higher than the prices paid in connection with existing stations. Klip power station was completed in 1940, at a cost of £15·4 per kilowatt installed; Vaal power station was completed in 1945 at £30 per kilowatt; the corresponding figure for Vierfontein, by 1955, is estimated at £55 per kilowatt.

The Commission's loan capital at the end of the year amounted to £50,503,330, total assets amounted to £69,492,449, and total liabilities £55,114,122. In its various undertakings the Commission, last year, consumed 6,365,573 tons of coal, an increase of 20 per cent, at a total cost, including transport, of £2,217,683.

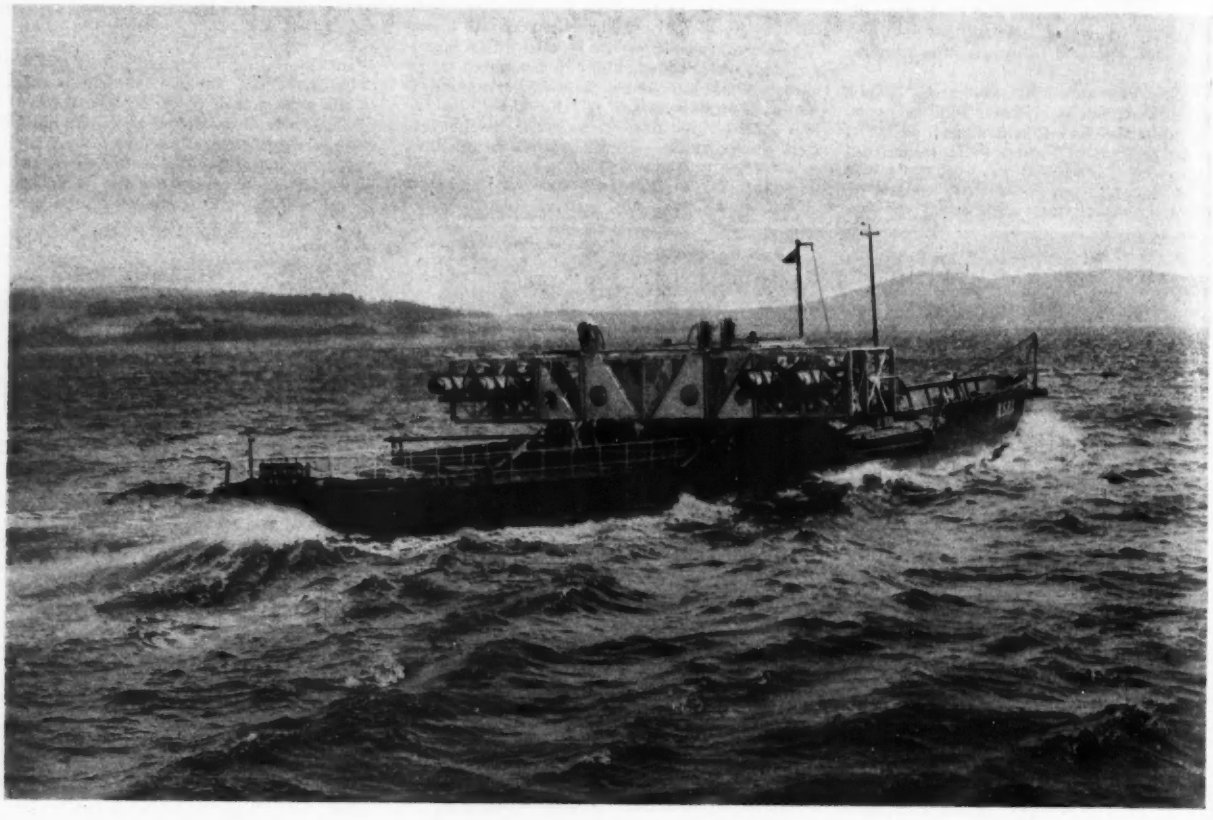
British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

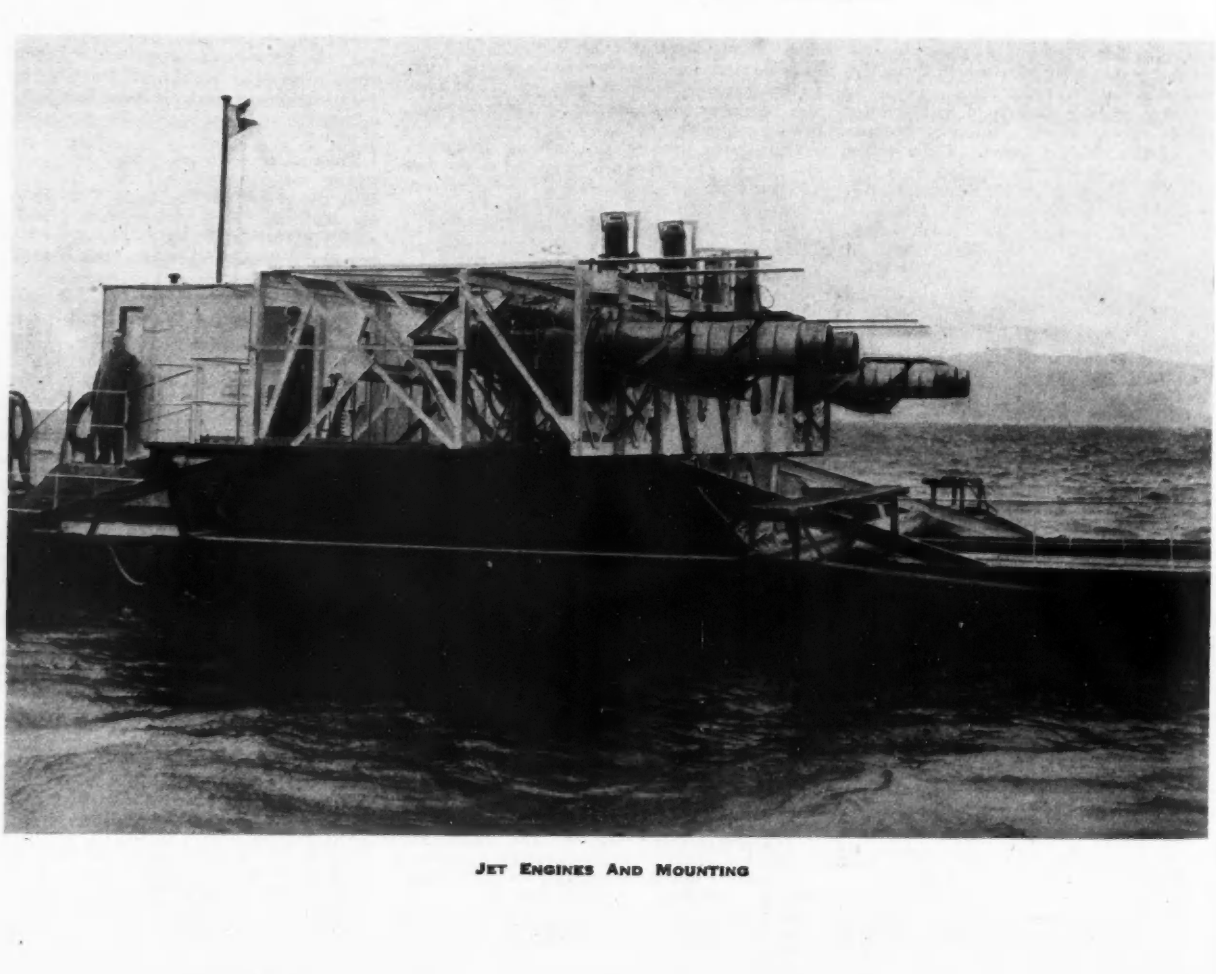
CIRCULAR SCREWING DIES AND HEXAGON DIE NUTS

No. 1127 : 1950. The first British Standard for Circular Screwing Dies and Hexagon Die Nuts was issued in 1943 as a War Emergency Standard, when its primary object was to bring about a simplification in the variety of outside diameters of circular screwing dies. Provision was made for nine outside diameters of circular dies, applicable to all sizes of thread up to 2in B.S. pipe (parallel) thread, any particular thread being associated with not more than three diameters of die. After review in the light of present-day conditions it has now been adopted as a British Standard and is issued in the form of a revision to permit the addition of dimensions for a comprehensive range of hexagon die nuts for all sizes of thread up to 4in B.S. pipe (parallel) thread. Price 1s. post free

HULL RESISTANCE RESEARCH SHIP "LUCY ASHTON"



"LUCY ASHTON" ON TRIAL



JET ENGINES AND MOUNTING

Research Ship "Lucy Ashton"

IN our issue of June 9th we made brief mention of the hull resistance experiments which were projected by the British Shipbuilding Research Association, and it was through the courtesy of this body that we were able to inspect the ship and the propulsion arrangements, and to learn something of the problems encountered and overcome in preparing for the trials. It is common knowledge that the effective horsepower required to drive a ship is estimated from the results obtained from tests made by running a scale model of the ship in an experimental tank, by using the law of comparison to expand the residuary resistance and by employing suitable constants to arrive at the frictional resistance. The object of the "Lucy Ashton" trials is to establish accurately the relationship between model results and the actual ship, a difficult problem which can only be solved by moving a vessel through water by means which preclude the flow of water round the hull from being affected by the method of propulsion.

The problem of resistance similarity has been discussed in many papers and it has been suggested that there was a great need for further investigation on thrust measurements and pressure distribution on ships in order to account for "Greyhound" discrepancies. The initiation of the trials marks the beginning of a series of tests, which, after an interval of nearly eighty years, repeat to some extent the historic experiments carried out by Mr. William Froude at Portsmouth in 1871. It was in that year that the "Greyhound," having a length between perpendiculars of 172ft 6in, and an extreme beam of 33ft 2in, was towed by H.M.S. "Active." The towing tests were carried out at three draughts, the maximum being 13ft 9in, which gave the vessel a displacement of 1161 tons, the midship section area being 339 square feet and the wetted surface 7540 square feet. The tow rope was attached to a boom rigged out from the side of the "Active" because it was essential that the "Greyhound" moved in water undisturbed by the wake of the towing vessel. A revolving cylinder recorded the speed and the horizontal pull on the tow rope.

"Lucy Ashton" Reconstruction

For the new series of experiments the old Clyde paddle steamer "Lucy Ashton," which had been sold out of the service of the British Railways, was rescued from the shipbreakers' yard of Metal Industries, Ltd., at Faslane. The vessel, which had been for many years identified with the Gareloch route, was built in 1888 by T. B. Sneath and Co., in the famous yard at Rutherglen, her dimensions being, length 190ft, breadth 21·1ft, and depth 7·2ft. William Denny and Brothers, Ltd., have been responsible for preparing the vessel, and now only the hull remains. The compound diagonal engine built by A. and J. Inglis, Ltd., in 1902, which replaced the original single diagonal engine built by Messrs. Hutson and Corbett, has been removed, together with the paddle-wheels, sponsons, deckhouses and fittings.

After considering different ways of measuring the resistance of the vessel, it was decided that propulsion by jet engines would give the best results because static thrust could be measured accurately and related to the hull resistance. Four Rolls-Royce "Derwent V" aircraft jet engines, two to port and two to starboard, have been mounted on specially built cradles suspended from a supporting framework built across the ship at about amidships, and extending beyond the beam of the ship. The engines have been carefully aligned so that the thrust is horizontal and in a forward and aft line and the height of the engines is such that the slip-streams are discharged well clear of the vessel and do not influence resistance.

Forward of the engine girder is built a sound-proof cabin, from which the ship is piloted and in which are mounted a number of instruments necessary for recording purposes. This cabin protects the crew and observers from the high-pitched engine noise and the sound-proofing effects a reduction of 60 phons to a level where ordinary conversation can be maintained. In the open it is necessary to wear protective ear-muffs or plugs. Below the deck cabin is a sound-proof control room, in which are placed the engine controls, thrust recording dials, instrument panels and battery-charging connections.

On the fore deck is a telescopic tubular mast of compressed, impregnated paper, and mounted on the masthead are electric and hand anemometers and a wind direction indicator. In what was the forward saloon a trim indicator is installed and two retractable Pitometer logs are to be fitted in this compartment, one at the forward and one at the aft end. These logs have a movement of approximately 30in and they will assist in assessing the thickness of the boundary layer. The adoption of jet propulsion meant that there were no means for stopping the ship, a rather essential requirement on the restricted waters of the Firth of Clyde, and this problem has been neatly solved by fitting brakes. These consist of heavy circular plates to port and starboard, hinged to a strong fender, which has been built to protect the transverse girder supporting the engines from damage by vessels coming alongside. The plate brakes are held in a horizontal position and controlled by a lever fitted close to the helmsman. Upon release, the brakes swing down into the water and are held in a vertical position by a wire rope attached to the foot of the plate and shackled at the other end to an eyeplate on the shell. Sand ballast has been used to compensate for the weight of equipment removed and to bring the vessel to the required trim and draught. The fuel consumption is approximately 1 lb per 1 lb of thrust per hour, and a tank having a capacity of 10 tons has been provided, which is adequate for the length of individual trials.

Trials

It is intended to carry out a series of progressive speed trials at two draughts, 4ft 3in and 5ft 3in, over a range of conditions, and to make basic recordings of resistance, speed and cognate data such as velocity distribution and thickness of the frictional belt. There are to be six double runs, in each of the series, and for every run the total resistance will be recorded by measuring the total thrust of the jet engines. From the results obtained a curve relating resistance to speed will be produced.

During the trials the vessel will be run with the sight edges of the seams brought into relief to simulate ship hull conditions, but as the seams of plating have single butt-straps fitted inside there will be no end-lap effect. Later, fairings will be applied to the seams and the effect measured of this added degree of smoothness. The actual degree of surface roughness will be measured at a number of points and an average value obtained; this was not done for the "Greyhound," which was copper sheathed. The effect of appendages upon resistance has always been difficult to assess from model experiments and after the tests with the naked hull it is planned to fit, first, dummy twin-screw bossings and, secondly, shaft brackets and propeller shafts but not propellers. The increase in resistance recorded over that of the naked hull over a range of speed will be the resistance of the appendages.

Apart from thrust measurements, it is hoped to arrange some trials to determine the turning moments exerted upon the ship by the rudder at different angles of helm and varying speeds by balancing the thrust of the pairs of jet engines on port and starboard sides to counteract rudder effect. After the completion of all the trials, with the hull in clean condition, the vessel will be allowed to become foul over a specified period and then a further series of resistance trials will be run to determine accurately the increase in the power required caused by this measured amount of fouling.

From offsets lifted from the actual vessel, a scale model has been made and all the ship's tests, except those under fouled conditions, will be repeated by an extensive series of tests in the experimental tank of William Denny and Brothers, Ltd.

Recording Instruments

The method employed to measure the thrust is by means of special hydraulic equipment, which has been supplied by Macklow-Smith, Ltd. As previously mentioned, each "Derwent V" engine is carried in a cradle suspended from a transverse girder by flat strips of spring steel, which allow the engine to move in a fore and aft direction and so exert pressure on the hydraulic measuring gear. The thrust of the jets is equalled by a reaction in a forward direction and the small movement is taken up by a hydraulic capsule, which actuates gauges mounted in the engine control room and which indicate the amount of thrust, some 4000 lb being the maximum to which it is intended to run each engine. The importance of the high degree of accuracy required in measuring the thrust is fully realised and the gear has been carefully checked by the de Havilland Engine Company, responsible for the installation. It has been calibrated at the National Physical Laboratory and is rechecked on board the vessel after each trial by a method used by the de Havilland Engine Company when testing their jet engines. This consists of a scale pan suspended from a bell-crank lever having parallel knife-edges, the lever being attached by links to the thrust bar at the forward end of the engine. By placing weights on the scale pan a known thrust is applied to the hydraulic capsule and checked with the gauge reading.

The time taken over the measured course is also a matter requiring accuracy, and a photo-finish technique will be employed simultaneously to photograph the mile-posts and a time record. This method will also serve to check any human errors which may be made by the normal stop-watch method. Another cine-camera will make a record at ten-second intervals of other data, such as wind direction, wind speed, compass bearing and helm angle, all of which will have to be taken into account when correlating the trial results.

It is an essential condition for the success of the trials that they must be run in ideal weather and smooth water with a clean hull, so that a datum for ship resistance measurement can be obtained which is comparable with that of the tank. Nursery trials have been held already, but the final preparation of the hull surface is taking rather longer than expected and this, together with other causes, has postponed the commencement of the trials until August 28th. With good weather being so essential, the trials will necessarily extend over a considerable period after that date.

The trials have evoked world-wide interest and the problems involved have called for considerable co-operation within and without the shipbuilding industry and assistance has been forthcoming from many sources, including, in addition to those already mentioned, the Air Ministry, the Ministry of Supply, Shell Mex, Streamline Filters, Ltd., and Vokes, Ltd.

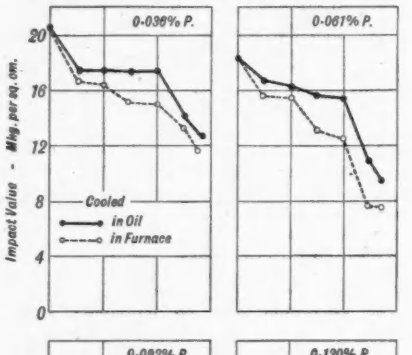
It is well-known that American naval architects are interested in the same propulsion problems and are carrying out a similar series of trials using a destroyer with aircraft engines and propellers for motive power. Under these circumstances the results of the "Ashton" trials will be awaited with more than the normal amount of interest, for, no doubt, they will solve many of the problems concerning the correlation of tank prediction with ship performance. The relationships, coefficients and constants so established may cause a new chapter to be written on the powering of ships, and the name "Lucy Ashton" to be associated with a momentous step forward in the science of naval architecture equal in importance to that made following upon the "Greyhound" experiments.

Metallurgical Topics

The Embrittlement of High-Phosphorus Steels on Tempering

THE well-recognised influence of high-phosphorus content in intensifying susceptibility to temper-brittleness induced E. Houdremont and H. Schrader, working in Krupp's research establishment, to carry out investigations to ascertain whether any connection could be found between the action of phosphorus in increasing susceptibility to temper-brittleness and the embrittling effect of phosphorus at room temperature. The recently published results of this investigation* include a number of interesting observations, and in particular demonstrate that the good impact figure obtainable in a high-phosphorus steel by rapid cooling from a suitable tempering temperature is not retained permanently at room temperature, but is subject to age-embrittlement.

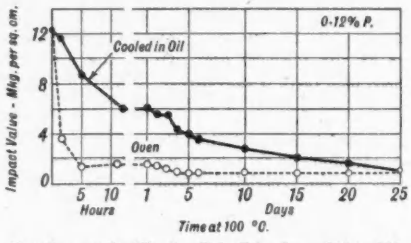
Experiments with Chromium-Nickel-Molybdenum Steel.—According to previous work, the lowest temperature at which embrittlement was produced by prolonged tempering (up to 1000 hours) was 400 deg. Cent., though a reduction in



Composition: Cr 3·1, Ni 1·0, Mo 0·33 per cent. Preliminary treatment: 850 deg./oil, 1 hour 650 deg./oil. Brinell hardness: 207 to 235. The numerals (5) and (27) are forging reductions.

FIG. 1—*Effect on Cr-Ni-Mo Steels with Different Phosphorus Contents of Tempering for Twenty-four Hours at Temperatures up to 550 Deg. Cent.*

impact figure was observed after longer times at 350 deg. Cent. Houdremont and Schrader set out to ascertain how the behaviour of steels after tempering at lower temperatures was affected by the presence of phosphorus. For this purpose they used four steels containing carbon 0·27, manganese 0·50, nickel 1·0, chromium 3·1, molybdenum 0·33 per cent, with 0·036, 0·061, 0·092 and 0·12 per cent of phosphorus. These were heat-treated by oil hardening from 850 deg. Cent., tempering at 650 deg. and cooling in oil. They all had a Brinell hardness number of about 225, and their impact values were from 21mkg to 13mkg per square centimetre, depending on the phosphorus content. These heat-treated steels were re-tempered at temperatures up to 550 deg. Cent for twenty-four hours and cooled in oil, or very slowly cooled in the furnace. All re-tempering resulted in a fall in impact value; the fall usually became considerable after re-tempering at above 400 deg. Cent., but with 0·092 per cent phosphorus re-tempering at 300 deg. Cent. followed by slow cooling at a rate of about 3 deg. per hour produced a sharp fall, and the effect was even more marked with 0·12 per cent of phosphorus after tempering at only 100 deg. Cent. In this steel a larger reduction of area in forging produced, as usual, material with a higher longitudinal impact figure. These effects are illustrated in Fig. 1. When slowly cooled after twenty-four hours' heating at 100 deg. Cent. the high-phosphorus steel showed almost as low an impact figure as after embrittling treatment at 500 deg. Cent.; and, given sufficient time at 100 deg., this result applied also to the material cooled in oil from that temperature. The minimum impact figure was reached after six hours' heating when slow cooling followed, but not until twenty to twenty-five days at 100 deg. if the specimen were subsequently cooled in oil (Fig. 2). A

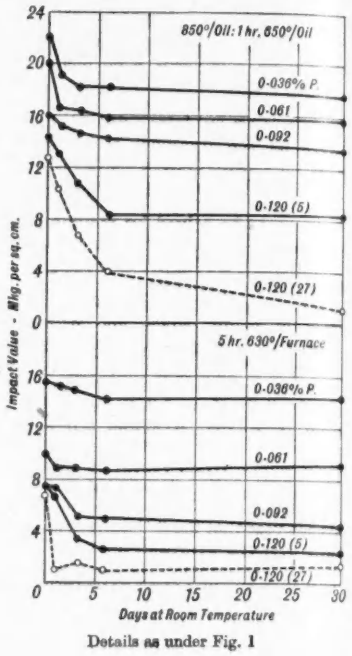


Details as under Fig. 1. Brinell hardness 226 to 237.

FIG. 2—*Effect on Cr-Ni-Mo Steel with 0·12 Per cent Phosphorus of Time of Heating at, and Rate of Cooling from 100 Deg. Cent.*

similar change occurred in the high-phosphorus steel merely on storage at room temperature; and this affected equally steel which had been toughened by cooling in oil from 650 deg. Cent. and that which had subsequently been through the embrittling treatment of slow cooling from 630 deg. Cent. (Fig. 3)

Experiments with Carbon Steels.—Carbon steels which had been water-quenched, tempered at 650 deg. Cent. for one hour and cooled in oil, showed a similar embrittlement on ageing at room temperature (Fig. 4). The steels contained either carbon 0·1, manganese 0·5, or carbon 0·45, manganese 0·75 per cent, in each case with phosphorus about 0·015, 0·065, 0·14 and 0·23 per cent. The shorter the time between oil-quenching from 650 deg. Cent. and carrying out the test the less was the fall in impact figure. Raising the hardening temperature from 770 deg. to 1150 deg. Cent. increased the amount by which the impact figure was reduced on ageing and the speed at which the reduction took place. When normalising, instead of hardening, preceded the oil-quenching from 650 deg. the initial differences in impact figure of the steels of different phosphorus contents were much greater, and the fall in impact figures on ageing was also greater especially in the low-phosphorus steel. The ageing effect was, however, minimised by increase in carbon to 0·45 per cent. In the 0·45 per cent carbon steels the difference originally existing as a result of different phosphorus contents remained, relatively, almost unchanged by ageing. The brittleness developed by ageing gradually disappeared when the steel was reheated at 400 deg. to 600 deg. Cent., though full restoration of the impact figure to its original value was only obtained by re-hardening and tempering. At



Details as under Fig. 1

FIG. 3—*Effect of Ageing at Room Temperature on the Impact Values of Cr-Ni-Mo Steels with Different Phosphorus Contents*

400 deg. to 600 deg. Cent. part of the constituent precipitated during ageing is re-dissolved in increasing amount with rising temperature and this results in a corresponding increase in impact figure. When this steel was again aged at room temperature or 100 deg.

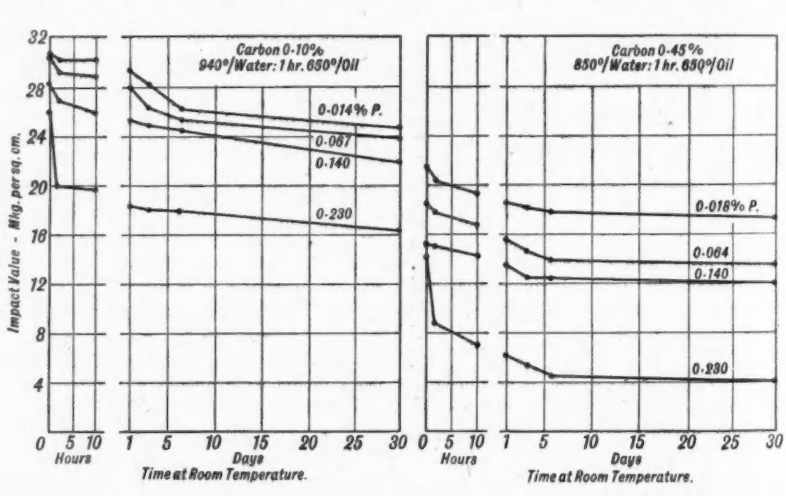


FIG. 4—*Effect of Ageing at Room Temperature on the Impact Value of Heat-Treated Carbon Steels with Different Phosphorus Contents*

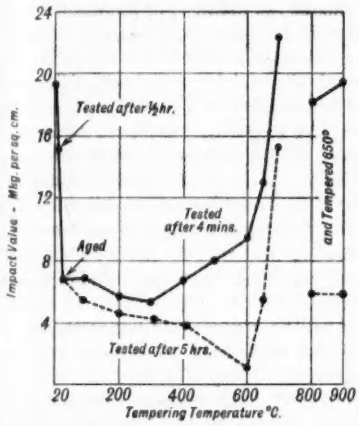
Cent. it embrittled even more strongly than the original material oil-quenched from 650 deg. Cent. This is taken by the authors to indicate that the presence of precipitated particles in partial solution is a strong stimulus for a new separation which, though smaller in amount, is finer in its state of division and causes more pronounced embrittlement. Fig. 5 represents the effect of ageing for five hours after the re-tempering of a steel containing carbon 0·45, phosphorus 0·23 per cent, previously oil-

* *Archiv für das Eisenhüttenwesen*, March/April, 1950, Vol. 21, page 97.

quenched from 650 deg. Cent. and aged at room temperature for three days.

Experiments with Nickel-Chromium Steels.—Results of some tests on nickel-chromium steels containing about 3·5 per cent of nickel and 0·7 per cent of chromium are illustrated by Fig. 6, which indicates the effect of high phosphorus in the presence of a low-carbon and a medium-carbon content. With high phosphorus, lowering of the impact figure by reheating became evident at quite low reheating temperatures.

Discussion of the Results.—Houdremont and Schrader distinguish between two effects in discussing the lowering of impact figure at temperatures below the usual temper-embrittling range :—(1) reduction of impact figure on



Preliminary treatment : 850 deg./water, 650 deg./oil. Then aged three days at 20 deg., tempered one hour at temperature shown, cooled in oil and tested after four minutes or five hours. Brinell hardness 259 to 269, except after 700 deg. (217)

FIG. 5—*Effect of Tempering on Heat-Treated and Aged 0·45 Per cent Carbon Steel Containing 0·23 Per Cent. Phosphorus*

ageing at room temperature or heating at 100 deg. Cent., evident even in low-phosphorus carbon steels and due to carbide precipitation ; and (2) an embrittling effect which in low-phosphorus steels ceases at about 400 deg. Cent., but which with high phosphorus extends downwards to lower temperatures. This phosphorus embrittlement is, they say, enhanced by increased carbon content, raised hardening temperature, increased grain size and smaller forging reduction, and is diminished by diffusion annealing. While this phosphorus embrittlement is, in the opinion of the authors, undoubtedly due to phosphide precipitation, they also incline to the view that phosphide precipitation in the range 400 deg. to 600 deg. Cent.

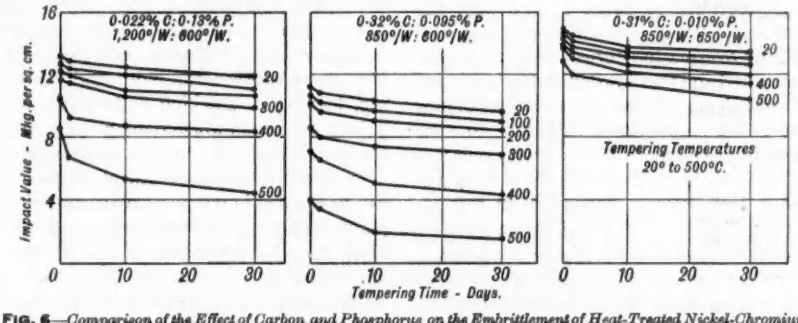


FIG. 6—*Comparison of the Effect of Carbon and Phosphorus on the Embrittlement of Heat-Treated Nickel-Chromium Steel (Ni 3·5, Cr 0·7 Per cent) by Tempering*

is the cause of, or at least substantially contributes to, temper-brittleness, and that when the phosphorus content is higher than usual precipitation of phosphide will continue to lower temperatures and, further, that high phosphorus may intensify the carbide separation involved in the first of the two effects mentioned above. In view of the fact that the solid solubility of phosphides in α-iron is known to be considerable, attention is directed by the authors to the possible effect of segregation, and the final conclusion is expressed that the mechanism of phosphorus embrittlement and of temper-brittleness is the same, and that in both cases it is a question of embrittlement through precipitation produced locally in regions of high phosphorus which owe their origin to crystal segregation.

Houdremont and Schrader follow Bennek and others in attaching primary importance to phosphorus as a factor in determining susceptibility to temper-brittleness ; but, apart from the fact that it is generally agreed to be a precipitation effect, the exact mechanism of temper-brittleness is not yet established. The rate at which embrittlement at room temperatures is produced is relatively rapid ; and this effect, especially as exemplified by the carbon steels, appears to be a manifestation of quench-age-embrittlement, which is known to result from ageing after quenching from 650 deg. to 700 deg. Cent., is more pronounced in steels previously annealed or normalised rather than hardened, and may well be intensified by the presence of a high-phosphorus content.

With reference to the behaviour of steels having a normal phosphorus content, there is little in the paper to call for a revision of present-day opinion or practice, except perhaps a warning not to disregard the possibility of some quench-age-embrittlement in steels rendered tough by rapid cooling from the tempering temperature—not a very serious matter on account of their high initial impact figure ; but the paper serves to emphasise the danger of high-phosphorus content by revealing the conditions which produce a hitherto unsuspected deterioration of impact values which may be associated with the presence of phosphorus in excessive amount.

Impact Value and Fatigue Strength

A QUESTION which frequently arises in connection with the design of components which have to withstand intermittent vibratory and shock stresses is to what extent, if any, does the ductility of the material as indicated by the notched-bar impact value influence its endurance under alternating stresses or modify its fatigue strength. This question has been re-examined in a paper by Anton Pomp and Max Hempel[1] on "Notched-bar impact value, endurance and fatigue strength under fluctuating tensile stresses, of smooth and notched specimens of different steels."

In the first part of the paper they review the results of a considerable number of previously reported investigations ; and sum up the matter by stating that they find no generally valid relationship between the magnitude of the fatigue strength, or the endurance at stresses above the fatigue limit (measured by the number of cycles to fracture), and the notched-bar impact value. The work reviewed covers a wide range of publications issued up to 1947. More evidence leading to the same conclusion has appeared since that date.[2] As confirmatory evidence of the independence of the two properties, Pomp and Hempel quote instances of tests at low temperatures in which the fatigue strength rises with rise in tensile strength, although the impact value will have fallen to a very low figure. In this connection reference may also be made to the valuable paper by J. L. Zambrow and M. G. Fontana[3] showing the pronounced increase in fatigue limit of some alloy steels at temperatures which produce a considerable fall in impact value ; and to a further paper by Pomp and Hempel[4] which gives numerous examples of the same effect.

To investigate the matter further Pomp and Hempel carried out tests on a hardened and tempered nickel-chromium steel in the tough and in the temper-brittle condition, and on two chromium-manganese steels, water quenched and tempered at 350 deg. Cent., to give an impact value of 1·7mkg per square centimetre, specimens of one of these being also tempered at 200 deg. Cent., giving an impact value of 8·9 with a slightly higher tensile strength. Ordinary tensile tests were carried out on smooth and notched specimens, and the same type of specimen was tested under fluctuating tensile stress. Some details of the results on the nickel-chromium steel are given in Table I. The ratio of tensile strength of the unnotched to the notched specimen was the same (0·83)

TABLE I.—*Results of Tensile, Notched-bar and Endurance Tests on Nickel-chromium Steel (Pomp and Hempel)*
C 0·25, Mn 0·53, Ni 3·48, Cr 0·90 per cent
Oil-hardened from 820 deg. Cent.; Tempered at 600 deg. Cent.

Stresses in kg per square millimetre	Cooled in furnace	Cooled in water
0·2 per cent Yield strength	70·7	71·5
Tensile strength	82·0	82·9
Elongation, per cent	22·6	22·6
Reduction of Area, per cent... ...	64	67
Impact value, mkg per square centimetre (Notch 1mm radius, 3mm deep)	5·6	14·3
Static Tests :		
Tensile Strength : Unnotched...	82·0	82·9
Notched ...	99·3	99·4
Ratio	0·826	0·834
Alternating Tests about a Mean Tensile Stress of 45kg per square millimetre :		
Endurance limit for 2 million Cycles : Unnotched 45± ...	24·0	24·5
Notched 45±	6·5	6·5
Ratio	3·70	3·75

for both tough and brittle conditions in the static tests. Similarly, the ratio of endurance limits for 2 million alternations of unnotched to notched specimen was the same (3·7) for both in the fatigue tests. The corresponding values for the chromium-manganese steel were 0·84 and about 6·0, the notch ultimately showing a greater relative effect in the harder steel, but not in the more brittle members of this group. Wöhler endurance curves and probable damage lines (i.e., ranges of overstress within which damage should not occur) were determined, and inspection of these led to the conclusion that steel with a low notched-bar impact value could withstand the type of stressing applied just as well as a steel of the same tensile strength and greater toughness.

These results are just what might be expected from a mass of previously recorded experience. The first points on the endurance curves represented about 1000 alternations and it seems certain that the notched-bar impact value only exerts an outweighing influence when fracture occurs at a single overstressing or after a very small number of alternations. The importance of a good notched-bar impact value in ensuring ductility under conditions of constraint or localised stress is not diminished by the fact that it does not influence the fatigue strength.

[1] *Archiv für das Eisenhüttenwesen*, 1950, vol 21, p. 67.
[2] For example, a paper by T. J. Dolan and C. S. Yen, reviewed in THE ENGINEER, July 29, 1949, p. 123.
[3] *Trans. American Society for Metals*, 1949, vol. 41, p. 480.
[4] *Archiv für das Eisenhüttenwesen*, 1950, vol. 21, p. 53.

THE MARCONI COMPANIES AND THEIR PEOPLE.—The first number of a new publication, entitled *The Marconi Companies and their People*, contains an introduction by the chairman, Sir George Nelson. The aim of the magazine is to give employees of the two companies—Marconi's Wireless Telegraph Company and Marconi Instruments—a record of their activities, including personal news about sport and the social side, as well as about work. Included in the varied contents of the first issue is an article by F. H. W. Gilmour on the Courtney flight in 1928, which demonstrated the practicability of carrying wireless equipment in aircraft on a transatlantic flight.

THE ENGINEER

AUGUST 25, 1950

VOL. CXC No. 4935

Contents

THE ENGINEER, August 25, 1950 PAGE

LEADING ARTICLES—
LABOUR POLICY AND ENGINEERS ... 208
AIR CONDITIONING AT THE NATIONAL GALLERY ... 208

SPECIAL ARTICLES—
DEFENCE ... 196
SOME AMERICAN LOCOMOTIVES AND THEIR RUNNING. No. III. (Illus.) ... 196
WARRAGAMBA DAM. (Illus.) ... 199

COMBINATION PISTON AND TURBINE ENGINE. (Illus.) 214
CONSTRUCTION OF LAMINATED PLASTIC PANELS. (Illus.) ... 202
HEAVY DUTY DRILL TESTING MACHINE. (Illus.) ... 216
HOTWIRE VACUUM GAUGE. (Illus.) ... 217
LARGE DIAMETER WELDED PIPE PLANT. (Illus.) ... 217
PROVISIONAL FORMULA FOR ESTIMATING THE STIFFNESS OF CRANKSHAFTS OF COMMERCIAL OIL ENGINES. (Illus.) ... 215
RESEARCH SHIP "LUCY ASHTON." (Illus.) ... 205
SOUTH AFRICAN ELECTRICITY SUPPLY COMMISSION 203
TURBINE OIL TANKER "VELUTINA." (Illus.) ... 211

METALLURGICAL TOPICS—
EMBRITTLEMENT OF HIGH PHOSPHORUS STEEL ON TEMPERING. (Illus.) ... 206
IMPACT VALUE AND FATIGUE STRENGTH ... 207

LETTERS TO THE EDITOR—
STRENGTH OF WELDS ... 209
SOME AMERICAN LOCOMOTIVES AND THEIR RUNNING 209

LITERATURE ... 210
BOOKS RECEIVED ... 210
SHORT NOTICES ... 210

OBITUARY—
FRANCIS LYDALL ... 209
SIR W. CHARLES WRIGHT ... 209

A SEVEN-DAY JOURNAL ... 195
CHIEF EXECUTIVE OF GUIDED WEAPONS
ENERGY IN THE SERVICE OF MAN
INDUSTRIAL FINISHES EXHIBITION
MERCHANT SHIPPING CASUALTIES
PUBLIC CONTROL OF INDUSTRY
REORGANISATION OF RAILWAY DISTRICT COMMERCIAL OFFICES
SILICEOUS PARTING POWDER IN FOUNDRIES

NEWS AND NOTES—
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 221
BRITISH STANDARDS INSTITUTION ... 203
FORTHCOMING ENGAGEMENTS ... 222
FRENCH ENGINEERING NEWS ... 220
INDUSTRIAL AND LABOUR NOTES ... 219
LAUNCHES AND TRIAL TRIPS ... 222
NOTES AND MEMORANDA ... 220
PERSONAL AND BUSINESS ... 222
TECHNICAL REPORTS ... 218

NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

LABOUR POLICY AND ENGINEERS

ENGINEERS and all those whose education has been scientific and critical must, we think, always read such "Party" documents as the statement of the policy and principles of British democratic Socialism issued this week under the title "Labour and the New Society" with impatience not untouched by scorn. For whatever their source such documents seem to those trained to greater precision of thought, unbalanced, untruthful, unfair and "woolly" in outlook. Party politicians love to wrap up their meanings in grandiloquent terms such as that they proclaim "all peoples have the right to live in peace," "the right to the full fruits of their industry," "the right to work," and so on, though they hesitate to define too closely what they mean. Nor are they ashamed to claim that all that seems good in the world has been the creation of their policies, nor that all that seems to them bad is the consequence of the folly or the wickedness of those who oppose them. The fact is, of course, that statements of Party policy necessarily take this unbalanced form. For the object of the Party policy makers is not to be precise, not to define policies upon which their parliamentary following will agree, but to state policies in such a way that neither the most nor the least radical of their supporters in the country can find cause for disagreement with them. Precision can hardly be expected when a paragraph that seems to those of the "Left" to foreshadow aggressively radical legislation must be designed for translation by those of the "Right" into a much more moderate meaning! But the wretched engineer, accustomed to the precision of argument to be found in an Institution paper or the report of a technical body finds himself very much at sea in trying to learn what is the real policy of the Party concerned.

Yet, though this Labour document suffers from all the usual defects of its kind, there does seem one point of policy mentioned in it that especially deserves the notice of engineers. In recommending—in the usual unspecific way—a "World Plan for Mutual Aid," it is remarked that "more than half the people of the world live in dire poverty. . . . One of the greatest tasks of the twentieth century is to see that they get a reasonable standard of food, shelter, clothing, health and education. . . . The undeveloped areas need technical assistance and the application of scientific research. . . . A revolution in primitive agriculture would increase food production. Irrigation would make the deserts fruitful. Roads and railways and ports would open up the backward areas to trade. Industry would follow. Millions throughout the world would be helped towards a fuller and healthier life." It is true that this conception is set out as though it were new and the discovery solely of the Labour Party; it is true there is no mention of the fact that for well over a century British "capitalists" and investors have risked money abroad on just such ventures as those mentioned; it is true that no mention is made of the numberless works directed to just such ends that have been designed and built by British engineers in all parts of the world, and that there is no acknowledgment of the work of British engineers in training men in other nations to carry on the task in their own lands; and it is true also that, except in a short sentence suggesting that wealthier nations have a "moral obligation" to help forward the poorer, there is no reference to the cost. Yet the proposal must necessarily arouse an echo of sympathy in the thoughts of engineers if only because so often in the past the influence of their work in pacifying and enriching oversea territories has gone almost unremarked and unrewarded by Governments and politicians. When, therefore, the organisation of the "technical service" to take knowledge, experience and skill wherever it is needed that is projected by the Government is more clearly defined, it is certain, we think, to receive sympathetic even if probably highly critical study by engineers.

For the rest, it does, perhaps, deserve some remark that there is some evidence in the document of a moderating enthusiasm amongst Labour party leaders for public ownership of industry. Indeed, in recommending that there should be "independent reviews of each public industry" from time to time, that "suitable arrangements should be made to ensure that . . . outside advice is enlisted upon particular problems of organisation and management," and that "the voice of the consumer must be more effectively heard," the Labour Party becomes implicitly critical of its own creations. Yet, so it seems to us after perusing the document, the Party still has much to learn about the functions of government. It still seems too concerned to "plan" and to "control" and too little concerned just humbly to "rule." It has yet to learn that, though in a turbulent and changing world there can, indeed, be defined objects of policy, plans can be effective only upon short terms; that, in short, most of the moves must be dictated by the expediency of the moment. Events in Korea and the now more fully recognised need to re-arm Western Europe emphasise the point. For increased expenditure upon armaments dictated by expediency must necessarily check the rate of advance towards those higher standards of living that it is the object of all parties to bring about. Indeed, a step back may need to be taken. Many of the measures that Sir Alfred Herbert, in a short article in this issue, urges upon this country out of his experience, twice, of seeing Britain go to war unprepared for the conflict will certainly be unpopular. For they run counter to the trend of post-war changes. It may be that, at present, they will be regarded as unnecessary. But were the emergency to deepen, can it be doubted that many of them would have to be adopted and that in consequence, temporarily at least, Labour doctrine would have to take the wall?

AIR CONDITIONING AT THE NATIONAL GALLERY

DURING the war the very valuable collection of paintings that is normally kept in the National Gallery in London had to be removed for safety lest it were damaged by bombs, gas, fire and water. The pictures were stored in caves and to protect them, air conditioning plant was installed. The paintings remained in the caves for the whole period of the war. They emerged, somewhat to everyone's surprise, not only little damaged but less damaged than they would have been had they continued to hang on exhibition at the Gallery! It was thereby revealed by a practical demonstration that one of the chief factors bringing about deterioration of paintings is the fluctuation of relative humidity. Repeated condensation upon the cool surfaces of the canvases, it has been found, is largely responsible for the deposition of dirt and grime; changes in relative humidity cause differential shrinkage and expansion between the paint and the backing, leading to cracking and flaking of the paint; and even worse damage may be done by the same means to paintings on panels.

Many of the lessons learnt in war-time can be applied in peace. An air conditioning plant has recently been completed at the National Gallery. The plant is capable of serving six galleries but at present it is serving only one. But if this experimental installation proves successful it is hoped eventually to extend the scheme to supply conditioned air to the whole building. The cleaned air is to be maintained continuously at a temperature of 65 deg. Fah. and a relative humidity of 58 per cent. As a direct consequence of air conditioning, it is believed that the rate of deterioration of the paintings will be reduced by 75 per cent. There will therefore be a less frequent need for that cleaning and repair of pictures

which has led to so much recent controversy amongst artists, many of whom, confronted by a painting from which the dirt and yellow varnish has been removed, have disapproved of the brilliant and usually colder colouring revealed. There is a further advantage and again one that may reduce controversy. Many of the paintings at the National Gallery have been placed behind glass for protection. That protection will no longer be necessary and with the removal of the glass much stronger illumination becomes possible since no reflective surface intervenes objectionably between the picture and the eye. Lighting, both natural and artificial, in the gallery concerned comes from a laylight ceiling 21ft above the floor in which five continuous lines of fluorescent lamps are concealed within deep louvres. Daylight is allowed to pass between the louvres in such a way that bands of shadow are avoided during periods of natural illumination. Intensities of illumination up to 15 foot candles and even 20 foot candles are being used. There are the further advantages that the " museum fatigue," so well known to visitors to public buildings, is likely to be reduced; and that the cleanliness of the air will make it possible to extend the use, becoming customary now at exhibitions of pictures, of textile hangings upon which, and among which, the paintings are believed to show to better advantage.

The gallery to which the air conditioning system has been applied was opened to the public on Monday last and the system will not be extended further until the criticisms of the public have been heard. Engineers, of course, malign themselves when they suggest they have little understanding of æsthetics. For there are very many of their products, whether or not consciously designed to do so—aircraft, locomotives, and many bridges leap to mind—which give æsthetic pleasure to those that behold them. But when, as at the National Gallery, paintings are concerned, criticism of the engineers' work must primarily come from those, the artists, who know how best pictures can be made to display their virtues. Yet, even if in referring to this installation at the National Gallery, engineers are likely modestly to restrict criticism to technicalities, the installation does still demonstrate how the work of engineers can be made to serve artistic as well as more ordinary utilitarian purposes. And why should it not? Indeed, is there, we wonder, any human activity that cannot be aided by engineers? For when heating and ventilating engineers have been confidently entrusted with the delicate task of keeping cool the heads of our legislators in the new House of Commons what remains that we can still think is beyond their powers? The provision of an atmosphere preservative of paintings becomes, surely, child's play by comparison!

Obituary

FRANCIS LYDALL

DURING the whole of his professional career Mr. Francis Lydall was concerned with electrification of railways, gaining a worldwide reputation in this particular field of engineering, and it is with regret that we record his death on August 15th, at the age of seventy-eight.

Francis Lydall was born in London and was educated privately, subsequently taking the degrees of B.Sc. at King's College, London, and B.A. at Cambridge. Before the first World War he worked on the manufacturing side of Siemens Brothers, and during the war served as assistant to the Director of Electric Power Supply. Later he joined the firm of Merz and McLellan, consulting engineers, becoming a partner in 1927 and retiring some eighteen months ago.

He was mainly interested in traction work and was responsible particularly for two main line electrifications, one in Natal and the other from Bombay over the Western Ghats. India knew him well, and he advised many of the Provincial Governments on their post-war electrification plans. Latterly he had been advising upon the future railway electrification in Great Britain.

Mr. Lydall was a member of the Institution of Electrical Engineers and of the Institute of Transport, and served on the councils of both bodies. In association with Professor Ernest Wilson he wrote a standard textbook on electric traction, and he contributed many papers to technical institutions. He had a great love of music and a particular knowledge of Bach, and his love of children found expression in service as a Governor of the Victoria Hospital for Children at Chelsea.

SIR W. CHARLES WRIGHT, BART.

THROUGHOUT the greater part of his long and distinguished career, Colonel Sir William Charles Wright was prominent in the work of the British steel industry, and his death, at Englemere Hill, Ascot, on August 14th, is deeply regretted. Sir Charles was the only son of the late Sir John Roper Wright, the first Baronet, and was born on January 12, 1876. As a young man he went into the works of Baldwins, Ltd., of which his father was a director and subsequently chairman, and in 1906 was appointed manager of that company's Port Talbot works. On the death of his father in 1926, Sir Charles succeeded to the chairmanship of Baldwins, Ltd.

A few years later there was an amalgamation of the heavy steel interests of Baldwins, Ltd., and Guest, Keen and Nettlefolds, Ltd., and a new company was incorporated under the title of Guest, Keen Baldwins Iron and Steel Company, Ltd. Sir Charles became managing director and subsequently chairman. Early in 1945 a merger was effected between Baldwins, Ltd., and Richard Thomas and Co., and Sir Charles then joined the board of Richard Thomas and Baldwins, Ltd., retaining the chairmanship of his former company, which was renamed Baldwins (Holdings), Ltd.

During the first World War Sir Charles was Controller of Iron and Steel Production in the Ministry of Munitions, and in the second World War he was called upon to serve in a similar position in the Ministry of Supply. At the end of 1942, however, he had to relinquish the office on account of ill-health, but returned a few months later as Assistant Controller of Iron and Steel Production. Sir Charles was elected to membership of the Iron and Steel Institute in 1902, and was its President from 1931 to 1933. He was also closely concerned with the work of the British Iron and Steel Federation, of which he was elected President in 1937. Sir Charles was Sheriff of Glamorganshire in 1912, was for many years a Justice of the Peace, and in his younger days devoted a great deal of time to the Glamorgan Royal Field (Reserve) Artillery, of which he was Honorary Colonel in 1909. He was made a C.B. in 1918, K.B.E. in 1920 and G.B.E. in 1943.

Letters to the Editor

(We do not hold ourselves responsible for the opinions o our correspondents)

STRENGTH OF WELDS

SIR,—The usual method of estimating the strength of a closed ring of welding in torsion involves the calculation of the centre of gravity and the polar moment of inertia of the ring of welds. A typical instance where this type of stressing occurs is in an eccentrically loaded bracket fillet welded to a supporting member with the load in the same plane as the weld.

A simpler formula can be derived from Professor Batho's formula, which may be stated as follows :—

If any thin-walled cylinder or prism, either continuous walled or of open framework, is subjected to a twisting moment T, the shear stress is given by

$$q=\frac{T}{2At} \quad . \quad . \quad . \quad . \quad (1)$$

where

q = shear stress.
T = twisting moment.
A = area bounded by the contour of the cross section of the prism.
t = wall thickness of prism.

This formula may be directly applied to a closed ring of weld provided t is taken equal to the throat thickness of the welds.

It is usually convenient to consider the strength of fillet welds in terms of the load per inch they will carry, F.

This is related to the stress across the throat of a weld as follows :—

$$F=q.a. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where

F = strength/inch of weld.
q = unit stress on weld.
a = throat thickness.

Substituting for q in (1) and putting $t=a$ gives

$$\frac{F}{a}=\frac{T}{2Aa} \text{ i.e., } F=\frac{T}{2A}.$$

Hence the strength of weld required to resist the torque T is obtained by dividing this torque by twice the area enclosed by the weld.

It would appear to the writer that the use of this simple formula is as much justified as is the use of the more arduous method generally advocated, and it would be of interest to learn whether any of your readers have information on tests on weld groups in torsion so that the accuracy of these methods may be compared.

For THE QUASI-ARC COMPANY, LIMITED,
A. G. THOMPSON,
MANAGER,
CONSTRUCTIONAL DESIGN DEPARTMENT
Bilston, August 16th.

SOME AMERICAN LOCOMOTIVES AND THEIR RUNNING

SIR,—In the last paragraph of Part I of Dr. Tuplin's interesting article, " Some American Locomotives and their Running," the writer, in commenting upon the American engineman's appearance, says that rimless spectacles are often worn by him.

This immediately arouses curiosity amongst those unfamiliar with American railroad regulations as to the standard of eyesight demanded of a footplate man.

So far as I am aware, the eyesight standard of British drivers must be such as to render lenses unnecessary.

Does this mean a lower standard in America, or are the lenses worn by their locomotive men merely a plain protective glass, acting somewhat in the nature of goggles?

WM. C. BUDD

Rugby, August 19th.

Literature

Clockmaking, Past and Present. By G. F. C. GORDON. Second edition. Revised by A. V. May. London: The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 17s. 6d. net.

ALTHOUGH approaching the subject from the angle of one who has been trained as an engineer, rather than a horologist, G. F. C. Gordon's book, "Clockmaking, Past and Present," first published in 1925, has won an acknowledged place in the horological library. For this reason the appearance of a revised and enlarged second edition is a welcome event.

The death of the author has rendered it necessary to entrust the revision to other hands and the choice fell upon Arthur V. May, who has carried out this work without making any extensive alterations to the original planning of the book. Indeed, a criticism that can be levelled at the second edition is that he could have done far more, in view of the developments which have taken place in clock design during recent years.

Perhaps Mr. May was hesitant to alter Mr. Gordon's statements, but it seems probable that if the author had still been alive to carry out the revision, he would have dealt far more drastically with the original—in the light of present-day standards. In any case, it is doubtful if he would have made the statement, in Mr. May's introduction, that "there has been nothing basically new since the anchor escapement was invented by Robert Hooke in the 1660's," and that it is "still the only satisfactory design for clocks with pendulums." Almost all horologists will take exception to these statements. Then, too, by no means everyone will agree with an additional editorial note, that "clockmakers take a poor view of what British-made products there are." This seems rather unfair to British manufacturers, who now market some excellent tools and materials for horologists.

The very good section on wheels and pinions seems as the author left it. It might have been improved by some description of the more modern methods of wheel and pinion cutting. The next chapter, that on escapements, seems limited to the construction of the "recoil," and we feel that it would have been better if the "dead-beat" and "lever" escapements had been included.

The chapter on striking mechanisms is good, so far as it goes, but here, again, no attempt seems to have been made to describe the "silently gathered" type of rackwork, which is now almost universal. The forms illustrated are those of the older kinds, used on bracket and long-case clocks, and few of these are made to-day. Later in the chapter, when gongs are being discussed, the comment is made that a rod-gong of the type now used for most chiming clocks, is "unquestionably very inferior to the coiled-type gong." Emphatic dissent will be felt by many for recent advances in technique have made the correctness of the statement very doubtful.

A very short chapter, consisting of two pages only, entitled, "British Clocks for Export and Use at Home," could easily have been expanded to a volume in itself, but it remains as in the 1925 edition. This seems a grave omission, for the growth of the British clockmaking industry during recent years has been almost phenomenal in its extent, and practically every type of clock is now produced in Britain, many in very large numbers. True, there is an editorial note at the end of the chapter, remarking that the position has changed since the first edition was published, but this, consisting of only four lines, cannot give any idea of the great developments that have taken place.

Sections on Restoration and Repair, Clock Trains, and American Clocks, all seem as in the first edition. Some of the statements made will not receive the approval of many horologists, and the concluding remarks in the chapter on American Clocks, in which Mr. Gordon expresses the opinion that no one can learn much about turning, polishing and similar processes from text-books may be true to some extent, but seem to do less than justice to several very excellent instructional manuals that are available.

The following chapter is devoted to turret clocks, and this should certainly have been revised. So much has happened in the design of this kind of clock that the matter here is rather out of date. An instance is the statement that the switchgear required for striking and chiming units of the motor-driven type would "prove complicated and costly." Modern designers have shown that the exact reverse is the case. The forecast that weight-driven clocks, wound electrically, would be standard for many years, has, however, proved true, and the comments on the way that architects still fail to understand the needs of a tower clock when designing towers should be taken to heart by all concerned with such things, for they are very pertinent indeed.

The bibliography is a good example of the strange inconsistencies that seem to occur in places in the book. In his introduction, Mr. May remarks that, since Mr. Gordon's work first appeared, many other books on horology have been published. Despite this, he has left the bibliography unaltered, no book later than 1924 being included.

The last part of the book is made up of two appendices, the more important being a reprint of part of the late Lord Grimthorpe's famous "Clocks, Watches and Bells," which, in its day, was one of the most valuable works of its kind. Even so, it is about half-a-century old, and so does not embody recent practice.

Electric clocks are barely mentioned, and, considering the importance which time-keepers of this kind have assumed, their omission makes the statement that Mr. May's revision has brought Mr. Gordon's original book into line with modern requirements, seem somewhat strange.

On the whole, it seems that, though good in its way, the book lives too much in the past. It is an account, and quite a good account, of certain types of clocks, and periods of clockmaking. A really comprehensive revision, bringing it truly up-to-date, would make it as valuable to-day as the first edition was in 1925. Failing this, the "Present" word in the title must remain rather a misnomer.

SHORT NOTICES

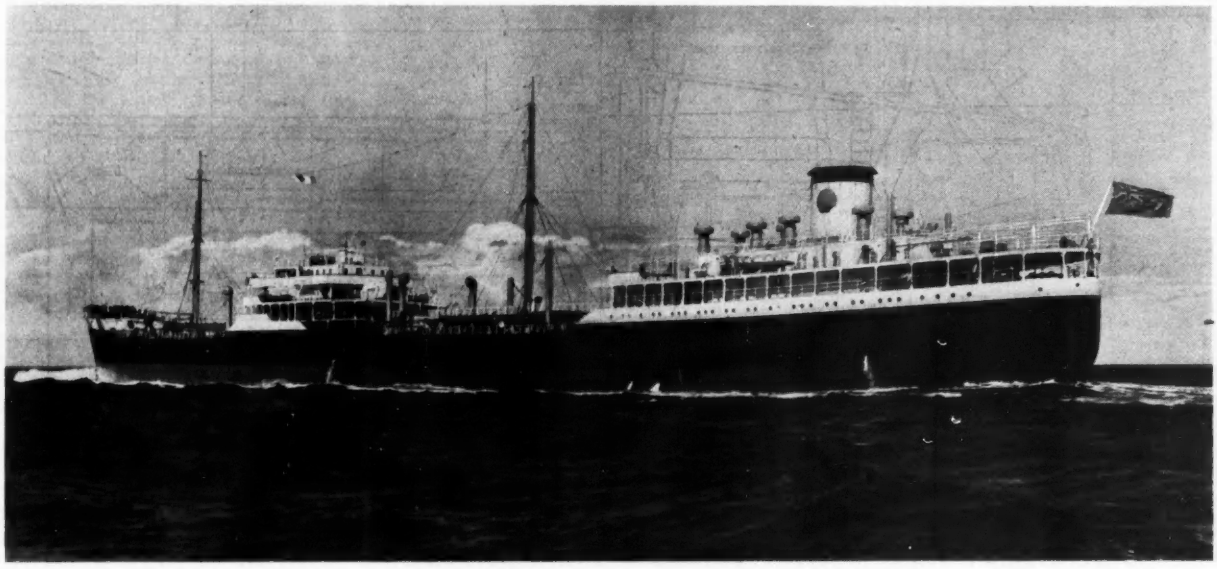
The Properties of Metallic Materials at Low Temperatures. By P. Litherland Teed. London: Chapman and Hall, Ltd. 1950. Price 21s.—This is the first of a series of monographs on metallic materials published under the authority of the Royal Aeronautical Society. The influence of extreme cold on the mechanical properties of metals is a matter of major importance in connection with aircraft. It is, therefore, appropriate that the Royal Aeronautical Society should have sponsored the publication of this monograph and that Major Teed, well known as an authority on aircraft materials, should have undertaken the work. This he has done with conspicuous success, assembling all that is best and most valuable in the world-wide output of information on the behaviour of metallic materials at low temperatures. The data presented have been critically examined to ensure that the composition of the material, its condition as regards mechanical or heat-treatment and other relevant details are recorded. Much published information is rendered valueless by the omission of such information, but nothing of the kind finds a place in this book. The result is that it provides authoritative information, to the full extent to which it is available, on the effect of sub-zero temperatures on the tensile properties, elastic moduli, fatigue resistance and notched-bar impact value of steels, aluminium, magnesium and copper and their alloys, as well as some additional information about other properties (e.g. electrical conductivity) and other metals such as nickel, zinc, tin and lead. There are still many deficiencies in the experimental data, and although there is at present no theoretical basis for predicting low-temperature properties from those determined at other temperatures, it is often possible to recognise a trend in the changing properties. The author is therefore from time to time able to give some reassuring comment, or to express a warning, or to frame some generalisation of the conditions which will ensure the best behaviour of a particular material at low temperatures. An example of this is found in the recommendations (page 111) as to the composition and treatment of structural steels to secure high notch-resistance down to −60 deg. Cent. Major Teed has rendered useful service not only to aeronautical engineers, but to those interested in mechanical refrigeration or even in the effect of ordinary sub-zero atmospheric temperatures, by providing easy access to the most trustworthy experimental data and valuable guidance in their interpretation.

British Diesel Engine Catalogue. By the British Internal Combustion Engine Manufacturers' Association. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 52s. 6d.—The success of the first edition of this work has prompted the issue of a second edition, which clearly indicates in its pages the advance and development in the oil engine industry since 1947. A Foreword gives a general review of the present position and summarises the important matters which have received special consideration. The whole of the book is technical, the introductory pages explain with diagrams the working principles of the diesel engine, deal with the question of engine ratings, including a table giving the derating per cent for combined engine-room temperature and humidity, specify fuel standards, define fuel terms and tests, diagrammatically illustrate the cylinder identification system, and give basic information regarding the power required for various drives. All the engines manufactured by members of the Association are listed in alphabetical order. They are fully illustrated, including detail drawings, performance charts and tabulated data. Information is easily abstracted by means of the Lightening Index, which groups the engines under five headings, namely, vertical and vee-form industrial engines, horizontal industrial engines, railway traction engines, marine propulsion engines, and marine auxiliary engines. The Foreword and certain of the introductory pages, including the instruction for use of the Lightening Index, are translated into French, Spanish and Portuguese.

THE LATE MR. G. W. ALLOTT.—We have learned with regret of the death, on August 14th, of Mr. Gerald William Allott, who, for many years, was on the technical sales staff of Newton Chambers and Co., Ltd., Sheffield. He entered the service of the company in 1900 and retired last year.

Turbine Oil Tanker "Velutina"

LAUNCHED on April 4th by H.R.H. Princess Margaret, the single-screw turbine oil tanker, "Velutina," is the first of the large tankers under construction for the Anglo-Saxon Petroleum Company, Ltd., to be completed. She will be followed at intervals by her three sister ships, two of which have already been launched, the "Verena," by Harland and Wolff, Ltd., at Belfast, and the "Volsella," by Cammell Laird and Co., Ltd., at Birkenhead. This latest and largest addition to the Shell tanker fleet has recently run trials off the Northumbrian coast and is expected to sail at an early date for the Persian Gulf, to load her first cargo of Middle East crude oil. Some of this oil will be refined at the new Shell Haven refineries in Essex, when that plant comes on stream later this year, and at Stanlow, Cheshire, after the completion of the Eastham oil dock at the entrance to the Manchester Ship Canal and the connecting land pipe line.



"VELUTINA" ON TRIAL

The general appearance of the vessel can be seen in the accompanying photograph, taken during trials, and the profile follows the usual tanker arrangement; there is a raked contour plate stem, a cruiser stern, two raked single-pole steel masts and a raked funnel. The ship's form was adopted after a series of models had been tested in the National Physical Laboratory tank at Teddington. She has been built to Lloyds Register of Shipping's highest class, + 100 A.1, "for carrying petroleum in bulk," and conforms with the latest requirements of the Ministry of Transport. The construction is on the combined transverse and longitudinal system, with transverse framing and deep webs in the side tanks and longitudinals at the upper deck and bottom shell in conjunction with two longitudinal bulkheads. In planning the constructional steelwork arrangements were made for welding as the principal means of joining. About 95 per cent of the steelwork, including seams and butts of bulkhead, decks and shell plating, bulkhead stiffeners, transverse and stringers, have all been welded and riveting has been employed only for connecting the side frames to the shell and transverse beams to the deck plating at the forward and after ends. A fabricated stern frame has been fitted, instead of the more usual casting, and takes a Simplex balanced rudder.

There are eleven groups of oil tanks, which are numbered from forward and each group consists of port, starboard and centre-line of the machinery space, in double-bottom tanks within the machinery space and in a deep tank forward. All the tanks are arranged for steam smothering and a Butterworth tank cleaning system has been installed.

Dimensions and Particulars

Length overall	643ft
Length between perpendiculars	610ft
Breadth moulded	80ft 6in
Depth to upper deck	45ft
Deadweight—summer draught	28,000 tons
Lloyds summer draught	34ft
Gross tonnage	18,619 tons approx.
Under deck tonnage	16,851 tons approx.
Net register tonnage	11,403 tons approx.
Displacement	37,500 tons approx.

Propelling Machinery

Type	Single-screw double-reduction geared turbine
Maximum power	13,000 s.h.p.
Propeller revolutions	106 r.p.m.
Normal service power	11,000 s.h.p.
Propeller revolutions	100 r.p.m.
Astern power	70 per cent of maximum ahead power
Boilers	Three Babcock and Wilcox single-pass design
Working pressure	500 lb per square inch gauge
Superheat	750 deg. Fah.

Electrical Machinery

Number of generators	Two B.T.H. Turbo-driven
Rating	400kW, 200V d.c.
Auxiliary services	Two B.T.H. electrically driven
Rating	45kW, 110V d.c.
Harbour services	One Ruston and Hornsby diesel-driven
Rating	135kW, 220V d.c.

The vessel is rigged in the usual manner, having two pole masts, the foremast being fitted with a 5-ton derrick to serve the forward hold, which is arranged to carry cased benzine, through a gastight hatch 8ft square. Other items of rig include two 3-ton derricks, provided for handling the oil cargo hoses and forward are two 1½-ton derricks for the loading of stores. In the aft well two 2-ton derricks are arranged for bringing stores on board, and to assist the arrangements the fore and aft gangway has been extended to port and starboard to form store unloading platforms. Two 10in by 16in John Lynn steam winches operate the derricks and are used for mooring purposes, one is forward of the bridge and has extended arms, the other, in the aft well, is mounted with the centre-line of the drums in a forward and aft line. The remaining deck machinery, supplied by Emerson Walker, Ltd., consists of two 13in by 10in capstans fitted on the poop deck, and also a windlass suitable for handling 2¾in Tayco cable, all taking steam from a deck line at 100 lb per square inch. The electric hydraulic steering gear, manufactured by John Hastie and Co., Ltd., works on the Hele-Shaw-Martineau principle and is arranged for Sperry gyro-pilot and telemotor control from the bridge. Adequate cold storage space, totalling about 1660 cubic feet, is arranged in the poop and the machinery, using Freon, is provided by the Lightfoot Refrigeration Company, Ltd. Fitted under "Optimum" davits are four Mechan's lifeboats, 24ft in length, one being fitted with an auxiliary motor, all the boats being shot-blasted and metal-sprayed as a measure of protection against corrosion.

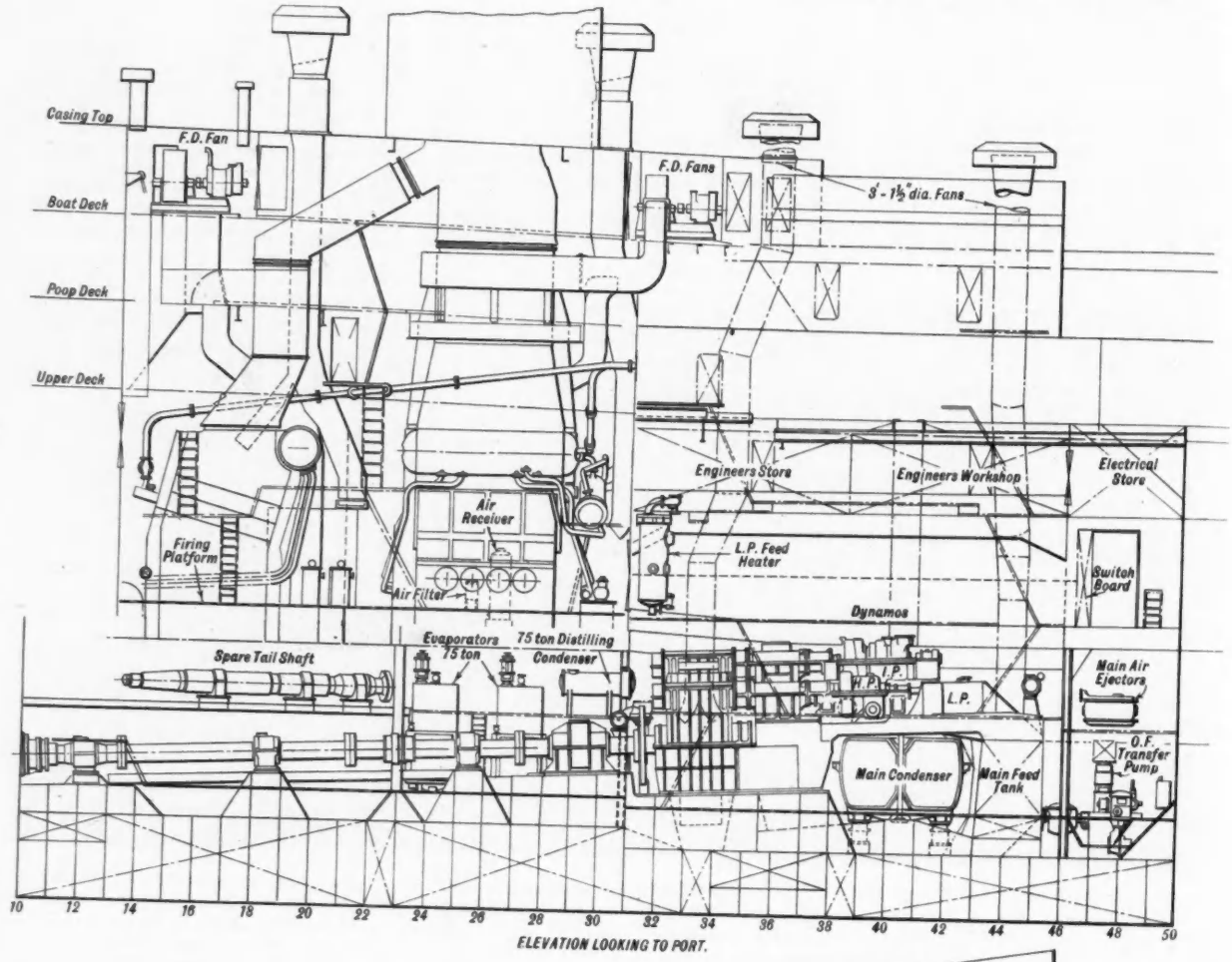
Accommodation

The captain's suite is arranged on the navigating bridge aft of the chart and wheelhouse, the hospital, officers' lounge, and the officers' and passenger's cabins are on the bridge and upper bridge decks, those for the passengers having separate bathrooms. A house on the poop deck accommodates the engineers, together with the catering staff and their mess. There is also a petty officer's mess and smoke-room, crew's messroom and the all-electric galley, close to which is placed the officers' and engineers' dining-saloon and smoke-room, which is a change from the customary disposition. The crew have their quarters within the poop, all have individual rooms and there are all the modern amenities, including a recreation space. Throughout the accommodation the heating and ventilation is by mechanical means.

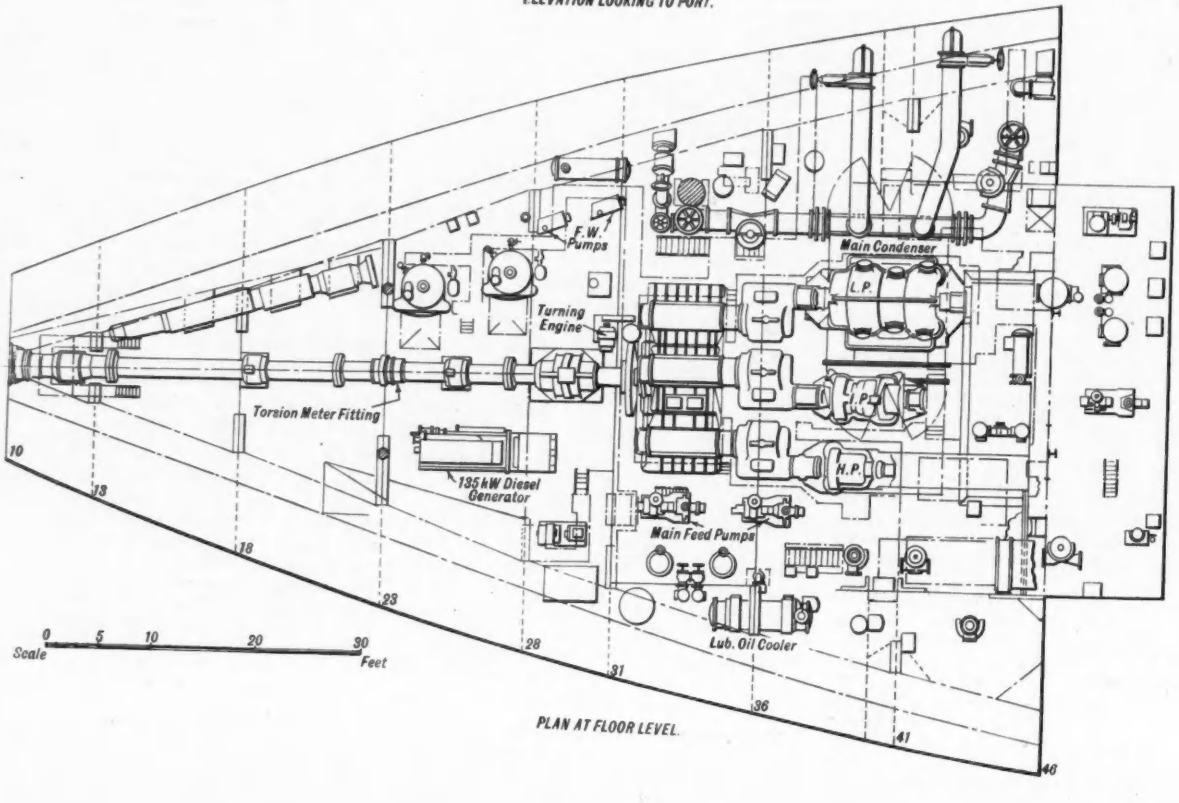
Cargo Pumping Arrangements

As already noted, there are two pump-rooms, the forward one between No. 3 and No. 4 tanks, and the aft room between No. 7 and No. 8 tanks. In each room are fitted two horizontal compound duplex steam pumps, 16in by 27in by 16in by 24in stroke, of Messrs. J. P. Halls'

MACHINERY ARRANGEMENT OF TURBINE OIL TANKER "VELUTINA"



ELEVATION LOOKING TO PORT.



PLAN AT FLOOR LEVEL.

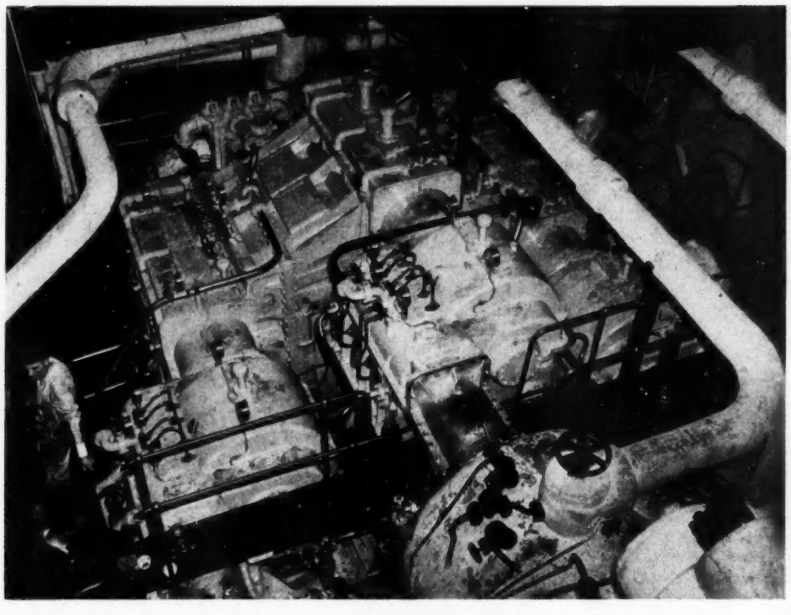
make, for handling the cargo oil. They take steam at 200 lb per square inch from a special steam line and have a capacity of approximately 500 tons per hour. The pumps are connected to the 12in diameter cast iron main pump-ring, which has the necessary cross connections, and there are 12in suctions to the centre tanks and 9in suctions to the wing tanks. The discharge is through a rising main and the usual deck discharge pipes, which are all 12in diameter; in this vessel, however, there is no stern oil discharge line fitted. A deck fuel line connects the deep tank forward with the oil fuel transfer pumps and consists of a 6in diameter steel pipe with 4in diameter branch suctions.

Propelling Machinery

The ship is propelled by a four-bladed, solid manganese bronze "Scimitar" propeller, driven by machinery built by the Wallsend Slipway and Engineering Company, Ltd., the general arrangement of which can be seen in our accompanying drawings, giving plan view and elevation. The main unit consists of one set of Parson's triple expansion double-reduction geared turbines of Pametrada design, taking steam at 500 lb per square inch gauge and 750 deg. Fah., and developing a maximum of 13,000 s.h.p. at propeller revolutions of 106 r.p.m, while the normal power is 11,000 s.h.p. at propeller revolutions of 100 r.p.m. The astern turbine develops 70 per cent of the maximum ahead power.

The h.p. ahead turbine and both the h.p. and l.p. astern turbines have impulse blading, while the i.p. and the double-flow i.p. ahead turbines are fitted with reaction blading. Accommodated in the i.p. casing is the h.p. astern turbine, consisting of one two-bucket wheel, while the l.p. astern turbine, consisting of one three-bucket wheel, is incorporated in the l.p. casing. Cast steel has been employed for the h.p. and i.p. casings and close-grained cast iron for the l.p. casing. The blading is of stainless iron and the rotors are of forged steel. Cast steel h.p. and l.p. nozzle chests have nozzle plates of steel, with stainless iron vanes. All the turbine bearings are of gunmetal lined with white metal and fitted in halves. The steam piping, which is of solid drawn cold finished steel, has connections so arranged that should an emergency arise any one turbine can be cut out and new connections made to enable the two remaining turbines to function.

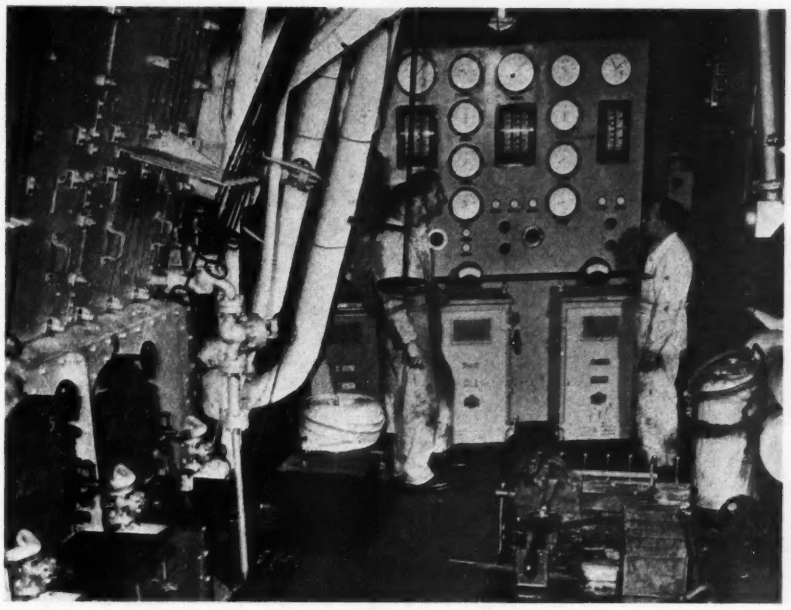
The double helical articulated gearing consists of a main wheel actuated by three pinions, which are driven by the h.p., i.p. and l.p. turbines working in series through double-reduction articulated gearing. Flexible claw couplings are used for connecting the turbines to the corresponding pinion shaft. Each primary gearwheel is fabricated, the forged steel rim being welded to a combined forged steel wheel centre and shaft and the main gearwheel has a built-up centre, with steel side plates, forged steel rim and shaft, all bolted together. The gear-casing is of fabricated mild steel. When developing maximum power the speed of the h.p. and i.p. turbines is about 3700 r.p.m. and that of the l.p. is about 3450 r.p.m. Forced lubrication has been adopted for all turbine and gearing bearings and for the main thrust block.



Engine Room

Boiler Plant

Three oil-fired Babcock and Wilcox single-pass marine boilers, having a total heating surface of 19,284 square feet and fitted with superheaters and tubular air heaters, supply steam at 500 lb per square inch gauge and 750 deg. Fah. direct to the main turbine, electric generator turbines, air ejectors and turbo feed pumps. Steam for other purposes is passed through desuperheaters fitted at the superheater outlet of each of the two forward boilers, being directly connected by a downcomer and upriser pipe, and each can desuperheat 40,000 lb of steam per hour from 750 deg. Fah.



Boiler Room

to 50 deg. Fah. above saturation. The boilers operate under forced draught on the open stokehold system, air being supplied by three Howden's electrically driven fans, each delivering 16,000 cubic feet of air at 80 deg. Fah. Mechanical soot blowers are provided for the boilers, superheaters and air-heaters. The oil fuel system burns "C" grade fuel and the duplex pumping and heating plant, consisting of two electrically driven oil fuel pumps and two fuel heaters, is capable of maintaining the fuel oil at 300 deg. Fah.

A Weir's regenerative condenser, with a surface area of 14,500 square feet, and capable of maintaining a vacuum of 28½in with the sea temperature of 70 deg. Fah., is slung under the l.p. turbine casing and has aluminium/brass tubes secured to end-plates by the John Crane process. Other equipment forming part of the Weir's closed-feed system, includes two three-stage steam-jet air ejectors and two three-stage turbine driven feed pumps, each capable of dealing with the whole of the boiler feed requirements, which amount to a maximum of 190,000 lb per hour. Two evaporators, each having a capacity of 75 tons per day, are provided, one to evaporate salt water and discharge the vapour through a distiller to the fresh water tanks, and the other to evaporate the fresh raw water, the vapour passing to the primary feed heater. The distiller, which condenses the vapour from the evaporator on salt water duty has a capacity of 75 tons per day.

Auxiliaries

Most of the auxiliary machinery is electrically driven and in the list are pumps by Worthington-Simpson, Drysdale, Stothert and Pitt. A surface condenser is fitted to take the exhaust steam from the oil cargo pumps and a de-oiler has been provided to deal with the contaminated returns from the heating coils.

Power for the auxiliary machinery is provided by two British-Thomson-Houston self-contained geared turbo-generators, one working and one standby, each rated at 400kW, 220V d.c. The lighting requirements are met by two British Thomson-Houston motor-driven generators, each having an output of 45kW, 110V d.c., and for harbour use a Ruston and Hornsby self-contained diesel generator, with an output of 135kW, 220V d.c., is installed.

A Combination Piston and Turbine Engine

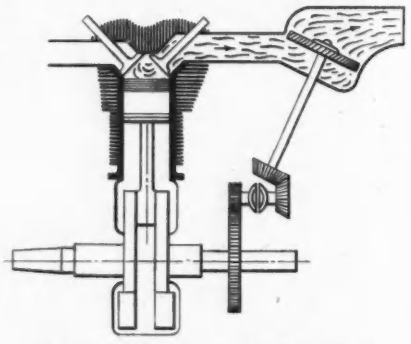
THE U.S. Navy's latest and farthest-ranging anti-submarine patrol bomber, the Lockheed P2V-4 "Neptune," is the first production aircraft fitted with a new type of combination piston and turbine engine, which is illustrated below. This Wright "Turbo-Cyclone 18" compound engine was developed under the sponsorship of the U.S. Navy by the Wright Aeronautical Corporation, Wood-Ridge, New Jersey, and is claimed to be the first compound piston and turbine engine to pass a military acceptance test and to go into quantity production. The development of this power unit dates back to January, 1946, when the company received a contract from the Navy Department Bureau of Aeronautics to make a design and performance study of such compound engines. First ground tests were conducted on a full-scale engine in May, 1947, and the first production engine was delivered to the Lockheed Aircraft Corporation for flight testing in a P2V-4 aircraft in December, 1949. The passing from an experimental to a production status of such a combination engine at this time is particularly significant in view of the present-day interest in jet transports. The aircraft industry generally recognises the advantages of the jet or turbine type of engine as a power plant for high-speed aircraft because of its compactness, or ability to produce large amounts of power from a relatively light and small machine. At the same time, it is agreed that the conventional piston engine has, so far, not been matched as far as reliability and economy of operation and maintenance are concerned. Aiming at a combination of the better features of each, it was decided to add a power recovery system to a conventional eighteen-cylinder piston engine.

After investigating the properties and performance of a number of power recovery systems, the company decided that:

(i) The collector ring system, which gathers exhaust from several cylinders into a common manifold from which the gases exhaust to the atmosphere, was unsuitable because very little energy in the exhaust was available for propulsion, since so much of it was lost in turbulence in the manifold or collector ring.

(ii) The individual jet stack installation, which consists of little more than exhaust stacks specially designed to utilise the exhaust velocity for jet thrust, was of questionable value when applied to long-range military aircraft and commercial transports, since the small increase in thrust gained through their use does not justify increased take-off loads.

(iii) The pressure turbine design, which uses a pressure turbine that is geared to the crankshaft and fed by an exhaust collector taking air from all cylinders to energise the turbine blades and in which the exhaust is first slowed down in the exhaust collector at relatively high pressure and then discharged through the turbine at high velocity, was unsuitable because



TURBINE POWER RECOVERY SYSTEM

the pressure which must be developed to provide the energy for this turbine sets up considerable back pressures.

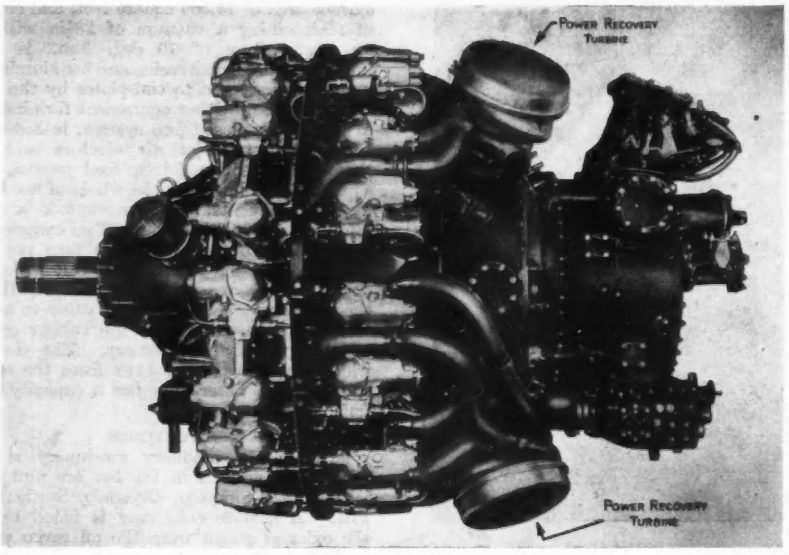
(iv) The blowdown or velocity turbine was the best power recovery system for long-range operation. In such an installation, which is illustrated diagrammatically above, gas is led individually from each stack at only a very slight increase above the back pressure encountered in discharging to the atmosphere. The high velocity of this gas energises the turbine with little pressure drop across the system. The advantage of improved cooling, reduced fuel consumption and reduced detonation which results from lowered back pressures in uncompounded engines may thus also be found in such a compounded engine.

The turbine drive system was designed in accordance with the cut-away view reproduced above. The piston engine has two banks of nine cylinders each. To avoid long, winding connections a simple piping arrangement was used. Six exhaust pipes feed each of the three turbines. Two front cylinder exhausts mate; a similar arrangement applies to two rear cylinders and another one to one front and one rear cylinder for each turbine. The turbine rotor has a mean diameter of about 10½in and rotates at approximately eight times crankshaft speed, 16,000 r.p.m. when cruising. The gas velocity at the turbine is supersonic and the temperature is in the region of 1500 deg. Fah., varying with mixture strength. It is of particular interest to note that the stellite blades of the turbines are not mechanically attached, but welded to the turbine rotor. This arrangement is said to give satisfactory results, even when blades have had to be replaced. The

TURBINE DRIVE

power generated by the turbine is fed through a pair of mating bevel gears, a fluid coupling, operating on engine oil, and a pair of spur gears directly to the crankshaft or main shaft of the basic piston engine. By transmitting the power through a fluid coupling any vibration forces in the turbine assembly are isolated from the crankshaft system and any vibration forces in the crankshaft system are isolated from the turbine assembly. Additional damping takes place by means of a spring-loaded, lubricated friction plate arrangement of bronze and steel surrounding the shaft mounting pedestal of the turbine.

The three turbines, which are an integral part of the engine, thus feed their recovered power directly back into the engine crankshaft system without impairing basic engine efficiency or adding stresses on reciprocating parts. No operating controls are required apart from those already used to operate the basic engine. Performance tests have shown that take-off power rating is 3250 h.p., a 20 per cent increase over that of the basic engine. Normal rated power is increased 14 per cent for low blower and 28 per cent for high blower operation. The weight per horsepower ratio is reduced to approximately 1 lb per horsepower. The fuel consumption is reduced 20 per cent for high cruise powers and 15 per cent for low cruise powers, and the Turbo-Cyclone 18 is claimed to have the lowest fuel consumption of any aircraft engine in production to-day. While at present



COMPOUND PISTON AND TURBINE ENGINE

being installed in the U.S. Navy's P2V-4 long-range anti-submarine patrol aircraft, the engine is also being considered for assault and troop transport and other applications in anti-submarine warfare.

A Provisional Formula for Estimating the Stiffness of Crankshafts of Commercial Oil Engines*

ONE of the earliest decisions taken by the British Internal Combustion Engine Research Association after its formation was that the subject of torsional vibration was of sufficient importance to warrant the creation of a special standing technical panel. The Torsional Vibration Panel was soon at work, and among the subjects selected for its immediate attention was the method of estimating the stiffness of crankshafts. Inquiries showed that in determining the stiffness of their crankshafts, members made use of one of the empirical formulæ for calculating the equivalent lengths of crank throws propounded by Ker Wilson, Geiger, Carter, Heldt and Jackson. In most cases slight modifications, based on experience with each particular type of engine, had been adopted.

The calculation of crankshaft stiffness is complicated by a number of factors, among which the following present the greatest difficulty :—

(*a*) Combined torsional and bending stress in the crankpin.

(*b*) Allowance for penetration of the pin and journal into the crank-web, and the effect of fillet radius.

(*c*) Correct conversion of the actions on the crankwebs into an equivalent twisting moment.

(*d*) The effect of the shape of the crankwebs.

It will be seen from Table I, which sets out the above-mentioned formulæ for calculating the equivalent length of crank throws, that there are differences in the allowances made to compensate for these factors.

In order to view the methods comparatively it was decided to apply all five formulæ to each of nineteen engines selected as typical of the whole range manufactured by the companies whose representatives constituted the panel, and to carry out torsiograph tests on the engines under specially standardised conditions with specified instrumentation.

Table II gives the deviations from the measured frequencies of the calculated frequencies, using the stiffnesses obtained by the five methods.

* Communicated by the British Internal Combustion Engine Research Association.

TABLE II.—*Deviations Resulting from the Use of Formulæ for Calculating Crankshaft Stiffness*

	No. of cyls.	Bore	Stroke	Measured frequency	Percentage deviation = (Calc. − Meas.) × 100 / Measured					
					Carter	Geiger	Heldt	Jackson	Ker Wilson	BICERA
1	5	9·055	11·818	4,610	+ 0·50	+ 3·15	+ 1·19	+1·85	+1·09	+0·98
2	7	9·055	11·818	3,710	+ 0·54	+ 5·93	+ 1·08	+2·02	0	0
3	6	8·50	13·00	4,635	− 4·30	− 0·70	− 3·70	−2·05	−4·30	0
4	3	8·50	13·00	6,180	− 1·30	+ 1·90	− 0·50	+0·97	−1·30	+2·59
5 (*a*)	3	10·50	13·50	5,900	− 5·76	− 0·17	− 4·91	−3·56	−3·73	−1·27
6 (*b*)	8	10·50	13·50	3,000	−11·43	− 1·00	−10·20	−8·34	−8·43	−3·50
7	6	10·00	12·00	4,350	− 5·30	+ 3·22	− 5·52	+0·12	−1·15	+3·22
8 (*c*)	6	15·00	20·00	2,565	− 4·10	− 2·20	− 5·00	−5·26	−6·40	+1·17
9	2	8·50	13·75	7,800	− 6·40	− 5·10	− 5·10	−5·89	−4·10	−3·52
10	8	8·50	13·75	3,900	− 0·05	− 0·50	0	−4·10	−1·80	+2·56
11 (*d*)	2	4·125	6·00	5,060	+ 5·14	+ 9·08	+ 6·32	+8·48	+6·71	0
12	5	4·125	6·00	12,410	− 0·08	+10·07	+ 0·001	+1·60	+2·90	+0·001
13	6	4·125	6·00	10,660	− 2·91	+ 7·12	− 2·16	+3·94	+0·66	−2·45
14	6	8·00	12·00	4,510	− 9·55	− 1·99	− 8·55	0	−5·74	−2·88
15 (*e*)	7	8·00	12·00	3,760	− 6·26	0	− 6·78	−5·05	−6·38	−0·53
16	5	11·00	15·00	4,000	−12·75	− 4·50	−11·12	−7·50	−7·75	−3·51
17	6	11·00	15·00	3,542	− 9·15	− 0·71	− 7·90	−5·98	−4·57	+1·92
18	8	16·00	21·50	2,200	−12·29	+ 0·91	−10·00	−5·90	−3·18	+2·95
19	8	12·50	15·00	2,400	+ 1·25	− 0·83	− 2·92	−3·34	−6·03	+2·92
Range of deviations, per cent					17·89	15·17	17·44	16·82	15·14	6·74

a and *b*—Scavenge pump at free end of shaft. *c*—Coupled to generator. *d*—Pulley at free end of shaft. *e*—Balance weights fitted.

It will be noted that the wide variations evident in terms given in Table I for the components of crankthrows tend towards compensation in the results obtained from the complete formulæ. Nevertheless, considerable divergencies are evident.

These results indicated clearly the need for experimental work aimed at producing a method of estimating crankshaft stiffnesses with greater reliability than is given by the use of empirical formulæ. It was realised, however, that this work, which was subsequently put in hand, would take some considerable time to complete, and an effort was therefore made to find a compromise formula that could be used without sacrifice of accuracy by all the designers concerned.

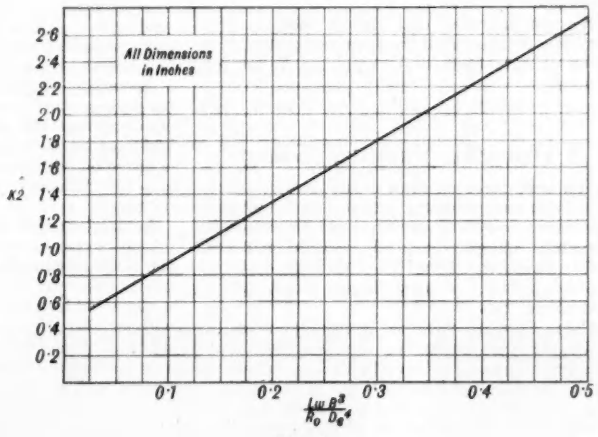


FIG. 1

Consideration of the results tabulated led to a decision to simplify the work involved by including a " crankweb factor " $2K$, which was calculated from the equation

$$L_{em} - (L_{ej} + L_{ec}) = 2K\, L_{ew},$$

where

L_{em} = total equivalent length calculated from the measured frequencies,
L_{ej} = theoretical equivalent length of the journal,
L_{ec} = theoretical equivalent length of the crankpin,
L_{ew} = theoretical equivalent length of the two crankwebs.

The average values of $2K$ were plotted against the corresponding values of $1/L_{ew}$ (i.e., $L_w B^3/R_o D_e^4$) for the range of engines considered, and the straight line curve thus obtained is shown in Fig. 1.

Results obtained by employing this crankweb factor still showed discrepancies in the case of crank throws with a small ratio of pin diameter to pin length, but a separate correction for the bending of the pin reduced the total error.

Based on the information provided by panel members, as referred to above, the following provisional BICERA formula was evolved by Mr. J. Smith, of the National Gas and Oil Engine Corporation, Ltd.:—

$$L = \underbrace{\frac{L_j D_e^4}{D_j^4 - d_j^4}}_{\text{Journal}} + \underbrace{\frac{L_c D_e^4}{D_c^4 - d_c^4}}_{\text{Crankpin twisting}} + \underbrace{\frac{0{\cdot}07\, L_c D_e^4}{R_o^2 (D_c^4 - d_c^4)}}_{\text{Crankpin bending}} + \underbrace{\frac{2K\, R_o D_e^4}{L_w B^3}}_{\text{Two crankwebs}}$$

where

L_j = journal length,
L_c = crankpin length,
D_e = diameter of shaft, equivalent,
D_j = diameter of journal (external),
d_j = diameter of journal (internal) = 0 for solid shafts,
D_c = diameter of crankpin (external),
d_c = diameter of crankpin (internal) = 0 for solid shafts,
$2K$ = constant, determined from Fig. 1,
L_e = length of shaft, equivalent,
R_o = radius of crank,
L_w = thickness of web,
B = breadth of web.

(All dimensions in inches)

Table II shows that the application of this provisional formula to the crankshafts of members' engines materially reduces the deviation from observed results, but it should be noted that it is derived from results of work on medium-sized engines with crankshafts whose journals range from 2·38in to 12in, and whose bore and stroke range from 4·125in by 6in to 16in by 21·5in. It is therefore not intended to apply to high-speed, lightweight engines, or to heavy marine units, but pending the completion of detailed torsional tests still in progress at the BICERA laboratories, it can be used to assess with a fair degree of accuracy the torsional stiffness of crankshafts in engines within the range covered.

In the BICERA laboratories the investiga-

TABLE I.—*Formulæ for Calculating the Equivalent Length of Crankshafts*

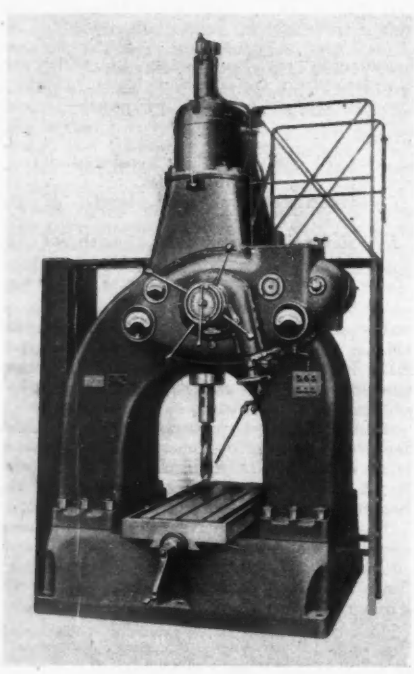
	Crank journal	Crankpin twisting	Crankpin bending	Crankwebs (two)
Carter	$\frac{(L_j + 0{\cdot}8L_w)D_e^4}{D_j^4 - d_j^4}$	$\frac{0{\cdot}75L_cD_e^4}{D_c^4 - d_c^4}$	—	$\frac{1{\cdot}5R_oD_e^4}{L_wB^3}$
Geiger	$\frac{(L_j + 0{\cdot}4L_w)D_e^4}{D_j^4 - d_j^4}$	$\frac{(L_c + 0{\cdot}4L_w)D_e^4}{D_c^4 - d_c^4}$	—	$\frac{0{\cdot}912(R_o - zD_j)D_e^4}{L_wB^3}$*
Heldt	$\frac{(L_j + 0{\cdot}4L_w)D_e^4}{D_j^4 - d_j^4}$	$\frac{1{\cdot}096L_cD_e^4}{D_c^4 - d_c^4}$	—	$\frac{1{\cdot}284R_oD_e^4}{L_wB^3}$
Jackson	$\frac{(L_j + 0{\cdot}27D_j)D_e^4}{D_j^4 - d_j^4}$	$\frac{(L_c + 0{\cdot}27D_c)D_e^4}{D_c^4 - d_c^4}$	$\frac{0{\cdot}07D_e^4(L_c + 0{\cdot}27D_c)^3}{R_o^2(D_c^4 - d_c^4)}$	$\frac{0{\cdot}7R_oD_e^4}{L_wB^3}$
Ker Wilson... ...	$\frac{(L_j + 0{\cdot}4D_j)D_e^4}{D_j^4 - d_j^4}$	$\frac{(L_c + 0{\cdot}4D_c)D_e^4}{D_c^4 - d_c^4}$	—	$\frac{[R_o - 0{\cdot}2(D_j + D_e)]D_e^4}{L_wB^3}$

* $z = 0$ for $B/D_j = 1{\cdot}60$ to $1{\cdot}63$ and $R_o/D_j = 1{\cdot}20$ to $0{\cdot}92$
$z = 0{\cdot}4$ for $B/D_j = 1{\cdot}49$ and $R_o/D_j = 0{\cdot}84$

tion of the various problems involved is continuing, and the experimental results obtained by utilising specially designed test rigs and extensive series of tests are being checked and collated with a view to establishing an accurate and reliable method of determining the torsional stiffness of crankchafts.

A Heavy Duty Drill Testing Machine

A HEAVY-DUTY machine for testing twist drills up to 3in diameter, built by Adcock and Shipley, Ltd., of Leicester, is illustrated in the engraving below. On machines used for this class of work a series of holes are drilled in a material of known specification, at set speeds and feeds, until the drill becomes blunt. The degree of bluntness is ascertained by the amount of power consumed in the operation. The "portal" design of machine illustrated is used in view of the high stresses encountered in this work. When the machine



DRILL TESTING MACHINE

was being designed the makers were careful to arrange the shape and sections of the main castings to have the maximum rigidity and minimum deflection. When testing the machine it was found that the maximum deflection when using 40 h.p. was 0·002in, measured from the table top to the section of the main casting in which the guide is mounted.

The main column of the machine is attached to the heavy box-section base casting by twelve 1¼in diameter studs and incorporates ribs and varying sections to deal satisfactorily with the bending, tension and compression stresses imposed during drilling. The table, which has a working surface of 54in by 18in, was machined from a solid block of steel. A screw and nut operated by a handle with a micrometric dial gives the table a traverse of 36in. A 9in diameter quill carried in a bore in the main column has a 2 D.P. rack machined on it. The spindle, which is 3½in diameter in the driving portion, is bored No. 6 Morse taper and runs in the quill in ball and roller bearings.

A 40 h.p. slip-ring motor mounted vertically, shaft uppermost, at the rear of the machine, drives directly to a gearbox on the top of the machine through two pairs of pick-off gears. Fast or slow gear is selected by a lever. Two hundred and sixty-nine spindle speeds are obtainable through thirty-six pick-off gears and the feeds range from ¾in to 60in per minute. The feed to the quill is from a 2 h.p., 940 r.p.m. flange-mounted motor, through two pairs of pick-off gears, a heavy worm reduction gear, a rack and pinion and epicyclic reduction gearing.

Slipping clutches are fitted to protect the feed mechanism both on the input and output side, because when a drill is completely destroyed very large stresses can be rapidly set up in the machine.

Control of the machine is in the first instance by stop and start press-buttons operating the spindle motor, feed motor and coolant pump motor separately. Hand feed by capstan handles is provided in addition to a slow hand feed by handwheel. Automatic feed can be engaged by movement of the hand feed capstan levers. Starting, stopping and reversing of the automatic feed is controlled by a lever at the front of the machine. The reverse movement of the feed is used to back out the drill and also to relieve the pressure on the feed clutches before the automatic feed is disengaged. Automatic depth control of drilling is effected by stops fitted to a plate at the front of the machine, which operate the automatic feed control lever.

The power being consumed during the drilling operation by the feed and spindle drive motors is indicated separately by two ammeters, which thus gives a measure of the torque being used and the thrust of the drill. Tachometers are fitted to indicate the spindle speed and the spindle feed rates.

A supply of coolant is fed to the drill by a pump mounted in a tank at the rear of the machine. In addition to a coolant trough machined round the table, a large splash tray is provided, which also acts as a guard to reduce danger from flying swarf and drill breakage.

We are informed that during tests on this machine a 2¾in drill was driven through a billet of tyre steel at a speed of 7·2in per minute.

A Hotwire Vacuum Gauge

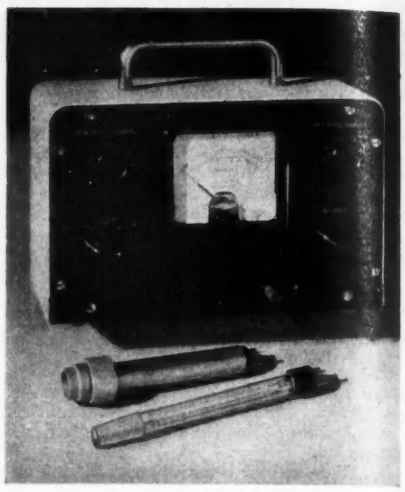
WE have received brief particulars of a hotwire (Pirani) vacuum gauge, designed for measuring low non-corrosive gas pressures in industrial or experimental vacuum systems, and manufactured by W. Edwards and Co. (London), Ltd., Worsley Bridge Road, Lower Sydenham, S.E.26.

This class of vacuum gauge operates by virtue of the change in temperature of an electrically heated filament, due to variations in the heat conductivity of the surrounding gas, depending on the pressure. Accordingly, a filament of tungsten, having a high temperature coefficient of resistivity, is arranged as one arm of a Wheatstone bridge. When the filament is subjected to any variation in pressure, the resulting change in filament temperature is reflected in the corresponding change in resistance, which, in turn, is conveniently indicated as an out-of-balance current on a meter.

As illustrated herewith, the gauge takes the form of a compact, portable instrument. Normally it is battery operated, but it has suitable connections for drawing power from an Edwards "Bantam" power unit, which can readily be plugged in to any 200–250V, single-phase, 50–60 c/s mains supply. The instrument itself is housed in an aluminium cabinet with a light grey "ripple" finish and a black anodised front panel, which incorporates the indicating meter and controls.

The meter is scaled to give direct pressure readings, for dry air, from 0·5mm to 0·001mm of mercury. The scale is also marked for setting the voltage before or during operation of the bridge circuit, making use of the "set volts" rheostat control knob on the lower right-hand side of the panel. To the left of the meter is a selector switch, which has positions for setting the volts, measuring the vacuum and for detecting leaks, using the technique referred to below.

As shown in our illustration, two gauge heads are available—the all-glass "G6" type or the metal "M6." Both heads have tungsten filaments designed to work at 200 deg. Fah., which is low enough to prevent damage in the event of exposure to atmosphere. The glass gauge head is connected to the vacuum system by a cone joint and, when not in use, can be clipped inside a compartment at the back of the instrument cabinet. The metal gauge head, on the other hand, is designed to be soldered to a ¼in bore copper tube. Both forms of gauge head are interchangeable without recalibration, for, attached to the head is a



HOTWIRE VACUUM GAUGE

calibration unit. This unit compensates for the ambient temperature and allows the bridge balance to be reset, if necessary.

Accurate pressure readings can be upset through contamination of the filament by process vapours. To remove this contamination and restore accuracy the instrument cabinet is provided with terminals whereby the filament can be "flashed" by current from a 10V battery.

Leak detection is effected with the help of an external galvanometer connected to the terminals on the front panel of the instrument. The procedure is to blow hydrogen on a suspected leak; if there is a leak the hydrogen will rapidly diffuse to the gauge-head under high vacuum conditions and will almost double the indication corresponding to any given pressure of dry air. The upper pair of control knobs, flanking the indicating meter, provide coarse and fine leak test settings, and very small pressure changes can be detected.

GRID REFERENCE SYSTEM ON ORDNANCE SURVEY MAPS.—The system of gridding Ordnance Survey maps of Great Britain produced and published for civil use is the same as that used by the armed Forces. There is, however, a slight difference between the civil and military methods of giving grid references, and it has been decided that the Ordnance Survey should adopt the military method as soon as practicable. The change of method will neither affect the general appearance of the maps in any way nor will it affect the "Normal National Grid Reference" now used on the civil small-scale maps of the Ordnance Survey, but the "Full National Grid Reference" will be modified so that the 100km square will be designated by two letters instead of by two figures and an oblique stroke. The method of giving map references on the Ordnance Survey large-scale plans will also be altered to conform. The change will be carried through gradually and no alteration will be made on maps that have already been printed.

PARTICLE ACCELERATOR LABORATORY AT QUEEN MARY COLLEGE.—Mr. R. L. Fortescue, M.A. (Cantab.), A.M.I.E.E., has been appointed as Senior Lecturer in charge of the Particle Accelerator Laboratory, the construction of which has been started at Queen Mary College, University of London. Since 1945 Mr. Fortescue has been working at the Atomic Energy Research Establishment at Harwell, as a Principal Scientific Officer. Machines used in nuclear physics and radio-therapy, and principles relating to the use of nuclear energy, will be studied in the new laboratory.

A Large-Diameter Welded Pipe Plant

A NEW pipe mill having an annual capacity of 100,000 tons of electric arc welded steel pipe, in sizes ranging from 26in to 36in diameter, started production recently at the National Works of the National Tube Company, McKeesport, Pennsylvania, a subsidiary of the United States Steel Corporation. The skelp, or plates, for the mill, vary from ¼in to ½in in thickness, and are of low carbon (0·20 to 0·30 per cent), high manganese (0·85 to 1·25 per cent) steel with an average weight of 2 tons each. Their standard length is 40ft 6in, while their width varies, according to pipe diameter, from 78½in to 110in.

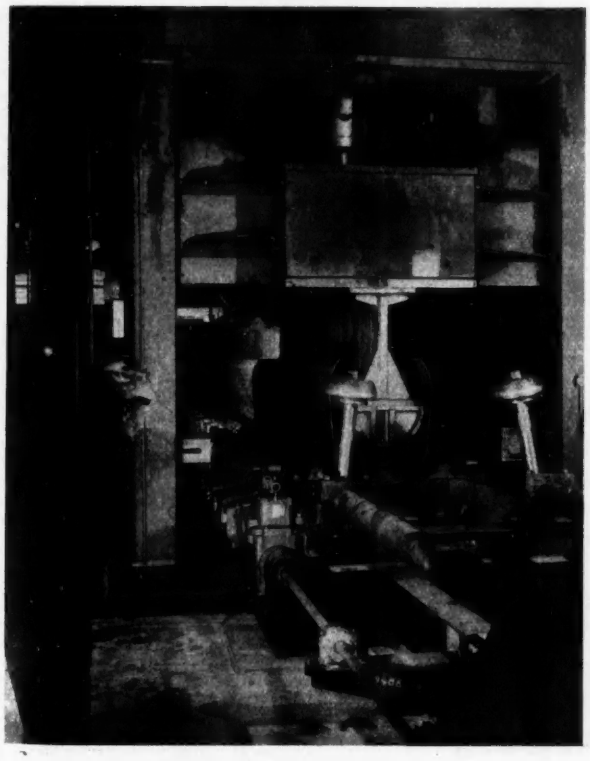
The fabrication of pipe from skelp is performed on a total of sixteen large machines, which are the major units of the mill. Extensive use is made of roller conveyors for moving the heavy material from unit to unit, making possible an assembly-line sequence of operations. The plates, which are rolled at the Homestead Works of the Carnegie-Illinois Steel Corporation, are unloaded at the west end of the new mill onto three stock piles, and the material enters the mill by means of a 10-ton crane and a transfer bogie of 10 tons capacity. Once the transfer bogie has been loaded, it is rolled into line with a conveyor table. Electro magnets mounted on a remote-control trolley feed the plates onto the conveyor leading to two end shears. These conventional down-cut guillotines are mounted together in line, at a constant distance from each other. The sheared plate moves onto a run-out table and is then conveyed by a drag chain to the planer feed table. Here a squaring mechanism aligns the plate to ensure accurate entry into the edge-planers. Each of these machines, set back to back, consists of a clamp-down bed and a moving platform, on each of which are mounted eleven cutters, which are off-set for increasingly deeper cuts and for bevelling. Plates are discharged from the planers by means of a pinch-roll drive and clamps on the movable platforms drag the next plate into position.

The planed and bevelled plate is now conveyed to another squaring mechanism, from which it enters a plate edge-forming machine. This consists of three adjustable rolls, which give a slight curve to the plate edges. From the edge rolls the plate is fed into the first of the two skelp forming presses by means of table rolls and a mechanical pusher. The two large forming presses were designed and built to fill a need arising from the demand for pipe for natural gas transmission lines. Originally, the very large diameter pipe used for this purpose was made in 30ft lengths and the plates were worked into tubular shape on bending rolls. When a demand arose for longer pipe lengths in order to reduce the time required by pipe-laying teams in welding pipe lengths together, difficulties were encountered in forming the plates. The bending rolls, it was found, did not operate satisfactorily on lengths beyond 30ft. Thus, adopting a new method, the so-called "U-ing" and "O-ing" presses were designed and built.

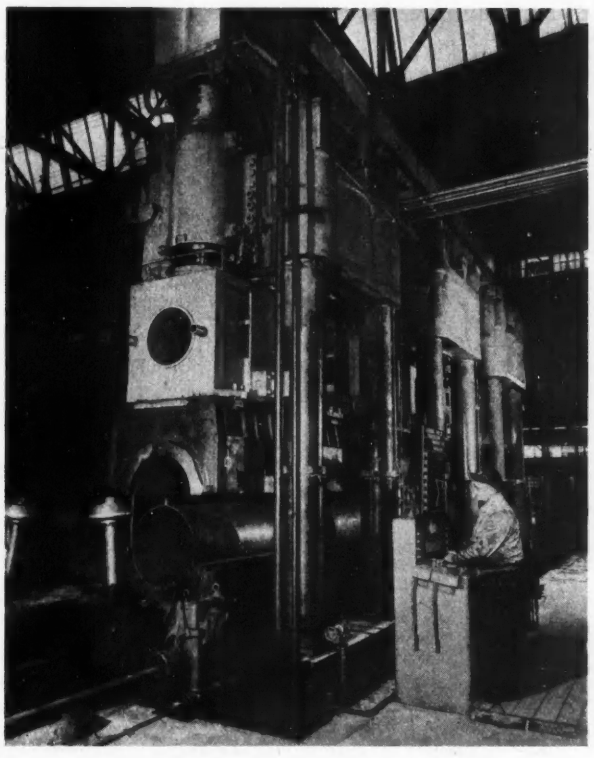
OUTSIDE WELDING MACHINE

The U-ing press, illustrated below consists of four presses in a line. Extending to a height of 19ft 4in above the floor level, it is 12ft wide and 41ft long. The press consists of four pistons, which are actuated by oil exerting a pressure of 3000 lb per square inch of ram area, equivalent to a total load of 2000 tons. A die, which is built up from steel plates and has a convex bottom, is attached to the four rams. Under the die, there are two rows of rocker arms, which form the lower die. When a steel plate has been placed on top of the rockers, the upper die is lowered. As the plate is pressed against the two rows of rockers, they turn downward toward each other. As one side of the rockers goes down, the other side goes up, pressing against the sides of the steel plate. This force from the outer part of the rocker arms bends the sides of the plate upward until they are perpendicular and form a U-shape. The total weight of the U-ing press is 370 tons, including dies.

A run-out table conveys the formed plate to the O-ing press. Again, a mechanical pusher feeds the plate into the machine. Extending 29ft 5in above the floor level, 10ft wide and 41ft long, the O-ing press, also shown below, consists of three presses in line. It

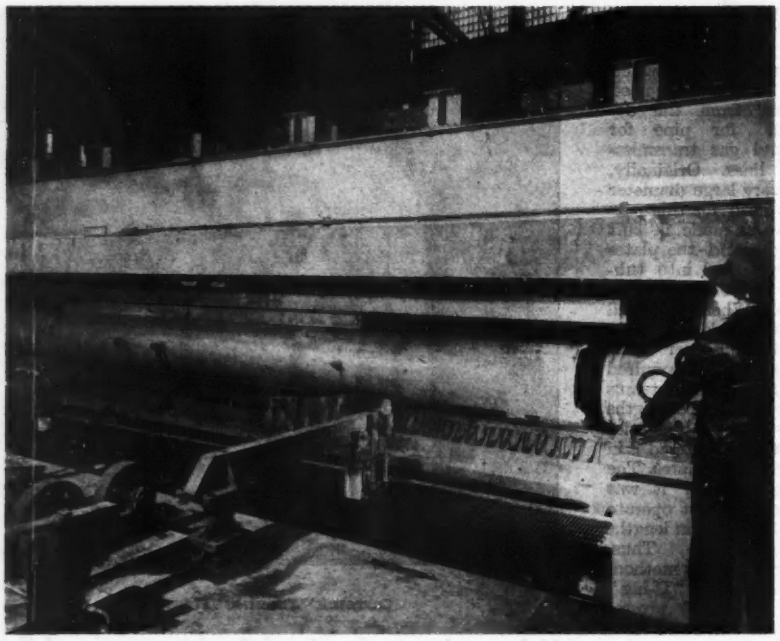


2,000 TON "U-ING" PRESS



18,000 TON "O-ING" PRESS

has a capacity of 18,000 tons, exerting a pressure of 3000 lb per square inch of ram area. There are three main rams, 65in in diameter, and three auxiliary rams 21in in diameter. The top die is attached to the rams, while the lower die is anchored within the press foundation. Both dies are concave and half-round in shape. When the U-shaped plate is pressed between these two dies, it assumes a circular



HYDRAULIC EXPANDING MACHINE IN OPEN POSITION

or "O"-shape and is known in the industry as a "can." Together with its dies, the O-ing press has a weight of 566 tons.

The circular shell is pushed out by the next U-plate, and pinch rolls feed it onto a conveyor. From the conveyor it is ejected on to a gravity transfer, which is adjustable by compressed air cylinders, to suit the rolling momentum of any diameter of shell. By a series of conveyors and skids the shell is then despatched to either one of two outside welding machines, illustrated on page 217. These units are submerged twin-arc a.c. fusion welding machines, both equipped with gas preheaters. The rate of feed of the shell is approximately 60in per minute. Flux is fed from an overhead bin and after the weld the unburned flux is picked up by a vacuum and returned to the overhead bin for re-use. A rotating disc shears off the burned flux, which is then removed by suction into a disposal hopper. The shell now moves to the semi-automatic submerged arc end-welding machines, where, to ensure a perfect weld and penetration on both pipe ends, about 6in of the seam are welded manually.

From this area the shells are rolled to two idler conveyors along which they are fed, at the operator's discretion, to either one of two inside welding machines. With the external weld downwards, the shell is placed on a movable carriage. The inside welding heads, mounted on fixed arms, were designed on the twin-arc principle and use d.c. on the leading and a.c. on the trailing arc. As in the case of the outside machines, the welding head is preceded by gas preheaters. A hopper on the end of the weld arm carries sufficient quantities of flux for each weld, and excess unburned flux is removed by suction. The pipe is then conveyed automatically to a flux remover, where the burned flux, knocked off by an automatic hammer operating externally, is removed by suction. From here the pipe is again automatically returned by conveyors to one of three tables for its first inspection and minor finishing operations, such as the chipping and grinding of the inside weld, to facilitate easier field welding assembly.

The welded shell now proceeds to the hydraulic expanding machine, which is shown herewith in the open position. The pipe is lifted into the machine and a tapered ram is inserted in each of its ends. Thus the ends are mechanically belled by the application of a horizontal force to the tapered rams. A rubber gasket seal on the ram ensures a water-tight connection. A four-section die, machined to the specified finished outside diameter of the pipe, is placed around the pipe, which is then filled with water under pressures up to 3000 lb per square inch (see illustration below). Besides being a reliable test of the soundness and strength of the arc weld, this expanding operation makes the pipe round, straight and of the correct diameter. Equally important, this expansion cold-works the steel, raising its circumferential yield strength and thus increasing the capacity of the pipe to withstand internal pressure. The thickness of the pipe walls determines the pressure applied for expansion purposes. As the pipe enlarges in diameter it is reduced in length. As it is reduced in length the tapered ram automatically advances to maintain a water-tight seal. Water pressure is then dropped below the point equivalent to the yield strength of the steel, the two end dies are opened and air hammers are struck against the pipe wall for testing purposes. If no leak appears, the other two dies are opened, the water pressure is again dropped and the entire weld is inspected visually for leaks. Three centrifugal pumps supply water to the hydraulic expanding machine from a 25,000 gallon reservoir. Pressure is applied by two accumulator systems, one of 3000 and one of 1200 lb per square inch capacity. Water leaving the expanding machine is drained into a sump and lip overflow from the sump into the reservoir ensures the circulation of only scale-free water. There is a scale bucket in the sump, to facilitate the recovery of scale and to keep the sump clean.

The expanded pipe is moved by conveyors to a double end-facing machine. Each of the two facing-heads is equipped with three cutters, which bevel and face the ends of the pipe. It then moves to two inspection areas: in the first area it receives a company inspection and in the second one a customer inspection. These areas are fitted with conveyors so that any pipe not passing inspection can be returned directly for repair.

HYDRAULIC EXPANDING MACHINE WITH DIES CLOSED

Technical Reports

A Measuring Diagram for Daylight Illumination. By P. J. Waldram, F.R.I.C.S. London: B. T. Batsford, Ltd., 15, North Audley Street, W.1. Price 5s.—The author points out that town planning regulations require all post-war buildings to leave adequate light and air to actual and potential neighbours as well as those for whom the buildings are constructed, thus calling upon architects to revive the almost lost art of scientific fenestration. In consequence a demand has arisen for information about the well-tried technique of measuring natural lighting, which hitherto had only interested specialists in "ancient light" litigation. The D.S.I.R. report No. 12 in the series of Post-War Building Studies is believed to be the only textbook now available on this subject, and its scope is limited to elementary problems only. The author has therefore prepared the present brochure in the hope that it will fill the gap until a more comprehensive textbook can be published. It contains copies of the measuring diagram in common use before the war for all problems, simple and complex, in the natural lighting of interiors, together with descriptions and instructions for setting it out if desired.

Industrial and Labour Notes

Confederation of Shipbuilding and Engineering Unions

The annual meeting of the Confederation of Shipbuilding and Engineering Unions began at Eastbourne on Tuesday last and ends to-day, Friday. It is being attended by representatives of thirty-seven affiliated unions, and twenty-two resolutions have been placed on the agenda.

Four of the resolutions relate directly to wages and profits, the first of them—submitted by the National Union of Vehicle Builders—urging "an early opening of negotiations to consider further the new wages structure for the engineering industry." The Amalgamated Engineering Union has put forward two resolutions on wages, one of which asks the Confederation's executive council to fix a date for the termination of negotiations on the new wages structure and suggesting that, failing a satisfactory conclusion, the matter be referred to a Government Court of Inquiry. The other resolution from the A.E.U. congratulates the Confederation's executive council on its efforts to achieve the £1 a week wage increase, "particularly in view of the latest statistics, which show that profits are reaching new high levels." The resolution charges the executive council with the responsibility of "actively progressing these wage claims."

In his presidential address, delivered on Tuesday morning, Mr. H. G. Brotherton dealt at some length with the £1 a week wage claim put forward at the end of last year on behalf of engineering and shipbuilding workers. Referring to the ballot on the matter, which was conducted recently by the Confederation, Mr. Brotherton claimed that the result showed that the Confederation's membership was conscious of the possible economic and political repercussions of a national stoppage in the industry. The majority of workers were obviously anxious to pursue every possible channel to secure redress for their grievances before resorting to strike action, and when an alternative to strike action was still available they preferred that it should be tested. Mr. Brotherton went on to say that the majority of workers were "still more than reluctant" to believe that the machinery for settling differences was incapable of affording justice in well-founded claims. It would be a gross provocation, he asserted, if, after "this expression of faith on the part of the workers, a satisfactory settlement was not reached."

Railway Wages

It was stated on Thursday of last week that the Railway Staff National Tribunal had decided that the Railway Executive should implement its offer to increase, by up to three shillings and sixpence a week, the wages of lower paid railwaymen. About 130,000 workers are affected by the increases, which operate from the beginning of the first full pay period after September 1st.

About a month ago the Railway Executive announced that it was prepared to make increases on these lines, and its offer was provisionally accepted by the National Union of Railwaymen. The two other railway unions, however—the Associated Society of Locomotive Engineers and Firemen and the Railway Clerks' Association—refused the offer in view of claims which they had submitted for general wage increases. The matter was then referred to the National Tribunal by the N.U.R.

Shortly after the Tribunal's decision was announced, the National Union of Railwaymen stated that it had submitted to the Railway Executive a claim for an increase of 10 per cent in the wages of all its members. It was stated also that the N.U.R. proposed to seek discussion with the other railway unions with a view to co-ordinating the wage claims which have now been put forward by the three railway unions. It will be recalled that the Railway Clerks' Association has made a claim for a wage increase of 7½ per cent and the Associated Society of Locomotive Engineers and Firemen a claim for a 15 per cent increase for footplate men.

Dismantling of German Plants

A spokesman for the American High Commissioner recently announced in Frankfurt that all dismantling operations in Western Germany, except for the removal of equipment from the Salzgitter works, will be completed by October 1st. About 44,000 tons of machinery and other industrial equipment remains to be dismantled in the British occupation area, and approximately 1200 tons in the American Zone. Dismantling has been completed in the French Zone. The spokesman went on to say that 411 plants out of the original 477 plants scheduled for dismantling in the British Zone had already been dealt with, and most of the works left had a capacity of only about 25 tons each. In the American Zone only one of the original 184 plants scheduled for dismantling remained to be dealt with. In the French Zone 103 plants of the 115 originally planned had been dismantled, and, as the remaining twelve were out of date, unprofitable or damaged, they would probably not be removed. It was considered that dismantling had reduced the steel production capacity of Germany by 6 million tons a year.

Training Courses for Trades Unionists

It has been announced by the Trades Union Congress General Council that during the coming winter the series of full-time monthly courses for trade union officials and active members of affiliated organisations will be continued. Four courses will be held between October, 1950, and March, 1951, and unions have been asked to send as soon as possible the names of prospective students for whom they will be providing scholarships. The applications by unions will receive priority, but individuals can apply to attend a course at their own expense provided the organisation to which they belong considers them suitable. Following the lines of previous courses the students will attend lectures and discussions led by members of the T.U.C. staff and other specialists. The courses will be supplemented by instructional visits to the National Arbitration Tribunal, the Industrial Court, and other institutions concerned with trades unions and industrial matters. The courses are non-residential and will be held from October 2 till October 27, 1950; November 6 till December 1, 1950; January 8 till February 2, 1951, and February 12 till March 9, 1951.

Industry and the Armament Programme

On Thursday of last week, the Minister of State for Economic Affairs, Mr. Hugh Gaitskell, met, separately, representatives of the Federation of British Industries, the British Employers' Confederation, and the Trades Union Congress for preliminary talks on matters likely to arise in connection with the nation's increased armament programme. An official statement issued after the meetings said that the Minister "reviewed the circumstances and went on to indicate some of the many problems of policy and administration which would obviously arise in the course of carrying out the programme."

It was emphasised that the aim must clearly be to secure the increased output of equipment as rapidly and efficiently as possible, at the same time causing the minimum of interference with economic recovery. The Minister agreed that there were many issues which it would be impossible to settle finally until further information about the extent of American aid became available. Meanwhile, he said, officials were making an examination of the possible impact of the programme on the national economy. It was agreed at each of the talks that further consultation would be necessary and that the most appropriate procedure to that end should be decided upon. It was hoped that Ministers would shortly have a special meeting with a committee of the National Production Advisory Council for Industry, on which the three organisations taking part in last week's talks are represented.

British Overseas Trade

Final figures of the United Kingdom's exports and imports in July have now been published by the Board of Trade. The value of exports was £182,300,000, a figure 8 per cent above the monthly average for the second quarter of this year, but slightly below the record for June, if allowance is made for the fact that June contained only twenty-five working days, compared with twenty-six in July. In volume, it is estimated that exports in July were 163 per cent of the 1947 monthly average, compared with 153 per cent in the second quarter of this year and 157 per cent in the first quarter. The value of imports in July was £225,200,000, a figure which maintained the high monthly average prevailing during the second quarter.

Comments made by the Board of Trade on July exports are that, although the total for the vehicles group showed a slight increase, overseas sales of new cars and chassis were 6 per cent lower than the average for the first six months of this year, and the value of new boats and ships, £3,100,000, was 26 per cent below the average for the first six months. On the other hand, "non-ferrous metals and manufactures" reached a record value of £7,400,000. This included the export of 3092 tons of tin, valued at £2,000,000, the highest quantity sent overseas for about four years. The bulk of it, the Board says, went to America.

Exports to the U.S.A. in July were valued at £11,300,000 (31,700,000 dollars), the highest figure so far reached in the export drive. July exports to Canada amounted in value to £10,500,000 (29,300,000 dollars) and were above the monthly average for the second quarter of the year. The combined value of exports to North America in July was thus 61,000,000 U.S. dollars, or 25 per cent above the average for the second quarter of this year and 21 per cent higher than the average for the record fourth quarter of 1948.

Lead and Copper Prices

At the beginning of this week the Ministry of Supply announced further increases in the prices of lead and copper. The price of good soft pig lead has been advanced by £8 from £104 to £112 a ton delivered.

From August 22nd the price of electrolytic copper has been increased from £186 to £202 a ton delivered to consumers' works. The Ministry's buying price for rough copper, in slabs of from 2 cwt to 3 cwt, has also been advanced from £144 to £156 per ton, though discounts, premiums and charges for forward delivery are unchanged. The Ministry says that these prices have been raised to safeguard the position in view of the increase made by United States producers in the price of copper. Another contributory factor is the pending discussions on the basis of the agreement reached in July with Northern Rhodesian producers, who stated that they would not wish to take advantage, in their pricing arrangements with the Ministry of Supply, of any increase in the American prices due to the imposition of the United States import duty.

French Engineering News

(From our French Correspondent)

Saar coal production for the first six months of this year reached 7,500,000 tons, an increase of about 600,000 tons over the first half of 1949. While internal consumption was slightly reduced over this period, deliveries to France increased and exports to Germany decreased. Several new markets were supplied and the demand increased from other consumers. Exports to Italy, for example, were 182,000 tons for the first half of 1950, compared with 118,000 tons in 1949, and the Austrian consumption increased from 13,000 tons to 34,000 tons. Exports to Sweden increased from 13,000 tons to 96,000 tons, to Denmark from 13,000 tons to 62,000 tons, and appreciable increases were also made in the quantities supplied to North Africa and Pakistan. It is believed that the development of certain of these markets will compensate for reduced orders from Germany.

* * *

A series of sleeping cars for the S.N.C.F. is now being constructed by the Ateliers de la Rhonelle. The cars are built in steel plate and are of all-welded construction, which is said to give a saving of 10 tons in weight per coach. Each coach weighs 37 tons, is 23m long and comprises nine compartments, taking forty-five passengers. The coaches are entirely air conditioned.

* * *

Under an agreement about to be concluded between the Ste. Renault and the Kelvinator-Nash automobile group of South Africa, Kelvinator-Nash will import unassembled Renault cars, which will be assembled in the Union.

* * *

A body known as the Association of Steel Products Consumers has been formed to support the Schuman coal and steel plan. This Association maintains that the pool will rationalise production and should bring down prices of both steel and coal. It also believes, however, that users of steel must be allowed to buy freely, where they will, and not be limited.

* * *

An exchange arrangement, which has been suspended since 1935, between Lorraine iron ore and Ruhr coke, has recently been restarted. Regular work will thus be provided for the Lorraine mines, which will supply to Germany some 130,000 tons of iron ore per month. These deliveries to Germany are being contested by the industry, however. It is stated by the industry that the quality of the Lorraine ore is poor and it is not worth the shipping cost to Germany. It is also pointed out that German industry has been trying to buy the richer ores which are scarce, from Normandy and even from French Guinea. These minerals, the industry says, are needed by France.

* * *

An export group for locomotives, known as "Gelsa," which was formed some time ago to investigate foreign markets, reports that the Brazilian railways have ordered ninety locomotives of different types, including a series of heavy locomotives. These locomotives will be delivered during the last nine months of 1951.

* * *

A large cement plant is to be built in Meknes, in Morocco. An agreement to this end has been reached between the Moroccan Government and the Societe Chaux, Ciments et Materiaux de Construction.

* * *

A motorway is at present being constructed between Casablanca and Rabat. It consists of dual carriageways, each about 24ft wide and separated by a central strip some 12ft wide, and its estimated capacity is about 15,000 vehicles daily. Provision is made for widening the carriageways in the future, should that prove to be necessary. The cost of construction is expected to amount to about £3½ million. The work will take several years to complete, and each section of road will be brought into service consecutively as it is finished. Some 14km have already been completed. Suspension bridges will be built over the wadis at several points.

Notes and Memoranda

Rail and Road

ROME UNDERGROUND RAILWAY.—The Italian Transport Minister is to ask Parliament for a 2500 million lire grant to complete Rome's first underground railway. Work on the underground, begun twelve years ago, was held up first by the war then by lack of funds. Now nearing completion, the underground will link Rome's central railway station with the southern outer suburbs of the city and the station at Ostia.

TRANSPORT USERS' CONSULTATIVE COMMITTEES.—Under the provisions of the Transport Act, 1947, the Minister of Transport has already established a Central Transport Consultative Committee for Great Britain, and Transport Users' Consultative Committees for Scotland, Wales and the London area. The Minister has now decided that Transport Users' Consultative Committees covering the remaining parts of England shall be set up for the following areas:—North-Eastern, Yorkshire, East Midland, West Midland, South-West, North-West, South-East and the East Anglia area. Parts of Buckinghamshire, Surrey, Kent, Hertfordshire and Essex are already included in the London area, and only those parts not so included will be covered by the new Committees. The Area Committees will be composed of an independent chairman and members representative of agriculture, commerce, industry, shipping, labour and local authorities, and the British Transport Commission, together with independent members selected by the Minister. The Committees, which will be concerned with both passenger and goods traffic, will consider any matters affecting the services provided by the British Transport Commission in their areas. The recommendations or conclusions of the Committees will be sent to the Central Transport Consultative Committee for Great Britain, and to the Commission.

Air and Water

DISCHARGE OF THE RIVER NILE.—The Egyptian Ministry of Public Works has recently issued a third supplement to Volume II of the report entitled "The Nile Basin." This supplement contains tables of the measured discharges of the Nile and its tributaries in the period 1938–42. Copies may be obtained from the Government Press, Cairo, at a price of 20s.

"FELIX ROUSSEL."—After an extensive refit, following upon years of war service as a troop transport, the passenger liner "Felix Roussel," of 17,083 gross tons, will re-enter the service of the Messageries Maritimes on August 24th. As reconstructed, the vessel carries two classes of passengers, 234 first and 83 tourist. The electrical equipment has been renewed but the original main propelling machinery has been retained. The external appearance of the vessel has been completely altered by the removal of the two square funnels and their replacement by a single streamlined funnel.

BOILER EXPLOSION.—The Ministry of Transport have issued its report of preliminary inquiry on the boiler explosion on board s.s. "Dransfield" while on passage on February 21, 1950. The boiler was of single-ended multitubular cylindrical pattern with two corrugated furnaces, and the explosion was caused by overheating of the tube plates due to shortness of water. The water gauge fittings were found to be choked by a soft deposit and the test cocks unworkable. The report states that the explosion need not have occurred had the water gauge cocks been properly used or the signs of obstruction in the passage of the water end cock correctly understood.

Miscellanea

IRISH MAIL VESSELS.—British Railways, London Midland Region, announce that one of their two new Irish mail vessels, "Cambria" and "Hibernia," intended for the Holyhead-Dun Laoghaire service, are to be fitted with stabilisers similar to those with which the "Invicta" is equipped. The first ship will be ready for the holiday season next year, and should the experiment prove successful the second ship will be similarly fitted.

THE YOUNG TROPHY.—The Young Trophy, awarded in competition between the London students of the Institutions of Civil, Mechanical and Electrical Engineers, has been retained by the Electricals for the third year running. They won the association football, table tennis, rifle shooting and cricket matches, but were beaten by the Civils at tennis. After the final matches on Saturday, July 29th, Mr. Arthur H. Young, son of the donor of the Trophy, presented it to Mr. I. J. Shelley, the chairman of the Institution of Electrical Engineers London Students' Section.

OIL TOWN IN BORNEO.—To replace the buildings destroyed by the Japanese and to house the increasing staff of the Seria oilfield, the Shell Petroleum Company, Ltd., are building a township of 700 houses in Brunei, British Borneo. Over 150 houses have already been built by the "Sifufoam" method on a site of 600 acres cleared in the jungle, and by 1952 it is hoped to accommodate all the 1500 employees.

THE SCIENTIFIC FILM ASSOCIATION.—The work of the Scientific Film Association is largely voluntary and covers a wide field. In a recent survey of makers and distributors of all kinds of films dealing with science in its many aspects, nearly a thousand companies and organisations were approached for information. The analysis of the replies has involved a large amount of detailed work and it is hoped that the outcome of this effort will result in an expansion of the Information Service which forms part of the Association's activities. The work of the Association includes the appraisal of films, and an appeal is being made for more members to join the specialist "Panels" which do the actual viewing of the films. Appraisal work now in progress includes films on chemistry, economics and electricity, and work about to begin will deal with films on workshop practice, anthropology and architecture.

HYDRAULIC DIAGRAMS NO. 3.—The third in the series of "Hydraulic Diagrams," published by the *Contractors' Record and Municipal Engineering*, Lennox House, Norfolk Street, London, W.C.2, has recently been issued. It is entitled "Design of Surface-Water Sewers: Frequency of Rain Storms," and, like its predecessors, it consists of a double-sided sheet of diagrams. The main diagram provides a trial-and-error method for the design of surface-water sewers according to the Lloyd-Davies formula. It is used in conjunction with a table giving the intensities of storms of different durations liable to occur once a year. Other tables given list the impermeability of various surfaces and a comparison of rainfall formulæ, and there is a diagram showing the probable frequencies of rainstorms of given intensity and duration. The price of the sheet of diagrams is 4s. per copy (3s. 6d. each for not less than six copies).

A NEW NIMONIC ALLOY.—The Mond Nickel Company, Ltd., is now able to refer publicly to the existence of the metal Nimonic 90, the latest addition to this series of nickel alloys. It is well known that further improvement of gas turbine thermal efficiencies await the development of turbine blading material which will sustain heavy stresses under high temperatures for periods at least consistent with the other engine components. These fundamentally opposed requirements have presented formidable problems to the metallurgist in recent years, and it must afford designers a measure of relief that this Nimonic series is keeping pace so successfully with this critical pursuit of ever higher temperatures and pressures in the thermal cycle. Details released of the Nimonic 90 show that at 750 deg. Cent. its performance is 10 per cent better than the Nimonic 80 and even at 870 deg. Cent. it withstands high loads for long periods very favourably. It is hoped that further information will shortly be available and the extent to which this material has already been used will be well indicated at the static exhibition in the forthcoming S.B.A.C. display.

A STUDIO WITHOUT ENGINEERS.—In the past the B.B.C. frequently has wished to include in its programmes a topical interview with some celebrity just disembarked from one of the transatlantic liners. This has meant the transport of an engineer and a duplicate set of outside broadcasting equipment from Bristol or some nearer point where the outside broadcasting staff were working at the moment. The dislocation in the planning and staffing of outside broadcasts has been unavoidable, and the cost in transport and engineer hours has been considerable. To meet the difficulty, the B.B.C. Engineering Division has experimentally installed an unattended set of studio equipment in the Guildhall at Southampton. The equipment will normally be locked up, but is installed in such a way that it can be switched on and send its programmes via the G.P.O. lines to Bristol without anyone being present other than the celebrity and the programme representative responsible for the interview. The programme representative will switch on the equipment, which is installed in duplicate, and the microphone output with the necessary amplification and electrical corrections will be received at Bristol, where it will be switched into the broadcast chain on a pre-arranged cue.

British Patent Specifications

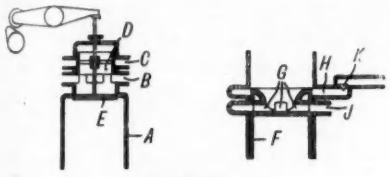
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

INTERNAL COMBUSTION ENGINES

640,505. July 18, 1946.—Improvements in or relating to Two-Stroke Cycle Internal Combustion Engines, Samuel Storm Riise, of Bjerkealleen, 25, Hovik pr., Oslo, Norway.

The present invention relates to a two-stroke cycle internal combustion engine in which the outflow of the exhaust gases takes place in two stages, the second stage being assisted by establishment of communication between the cylinder and a vacuous or sub-atmospheric space external to the cylinder. In accordance with the left-hand drawing, the working cylinder *A* is provided with two exhaust openings *B* and *C*, controlled by a slide valve *D*, which is connected to the master exhaust valve *E* of the cylinder. The slide valve *D* controls the first and second exhaust stages through the openings *B* and *C*. The inflow of scavenge air occurs through ports in the cylinder *A*, controlled by the working piston, which ports are not, however, shown in the drawing. The intake port area and the area of the exhaust

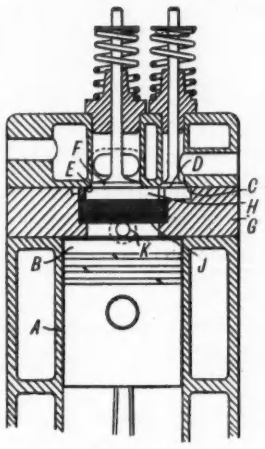


No. 640,505

port must be so arranged as to ensure that the amount of new charge flowing to the cylinder during the scavenging period will cause a rise in pressure in the cylinder to near atmospheric pressure or higher at the end of the scavenging period. In the right-hand drawing *F* designates the working piston, which is in this case provided with channels *G* in its top portion, which channels serve to place the working cylinder in communication with the exhaust ports *H* and *J*. The mode of operation will be as in the previously described example, the first exhaust taking place through port *H* via the channel *G*, and in this case the conduit of exhaust port *H* is shown provided with a non-return valve *K* for preventing a return flow of gas to the cylinder. Pressure curves and exhaust opening diagrams are given in an embodiment of the invention found to give good results. A cylinder of 500mm bore, stroke 900mm, and associated with a receiver 1·5 the capacity of the cylinder, was provided with scavenging and second stage exhaust ports of areas (when full open) of 500 square centimetres and 475 square centimetres, respectively, both the ports being controlled by valves timed to open at 36 deg. before B.D.C., and to close at 36 deg. after B.D.C. The receiver was under the continuous action of a suction pump operating to reduce the receiver pressure to 85mm Hg. below atmospheric pressure immediately prior to the establishment of communication between the receiver and cylinder.—*July* 19, 1950.

640,410. February 26, 1948.—Internal Combustion Engine Employing a Regenerator for Heating the Charge.—The "Shell" Refining and Marketing Company, Ltd., of St. Helens Court, Great St. Helens, London, E.C.3, and Isaac Lubbock and Richard Rigby, B.Eng., Ph.D., both of the company's address.

This invention relates to reciprocating internal combustion engines, in which a charge of fuel and a charge of a gas capable of supporting combustion are introduced into the cylinder and, after combustion of the fuel and expansion of the gases to perform useful work, the products of combustion are rejected. The invention enables the thermal efficiency to be increased with a given expansion ratio by providing in a reciprocating internal combustion engine a regenerator; means for causing the exhaust gas to pass through the regenerator; means for causing a fresh charge, at approximately the initial combustion pressure, to pass through the regenerator after, and in counter-current to, the passage of the exhaust gas therethrough, and then to enter the cylinder at or near the top dead centre immediately preceding the power stroke; and means for adding fuel to the charge after it has passed through the regenerator. The engine shown in the drawing comprises a cylinder *A*, a piston *B*, an air inlet port *C*, and valve *D*, and an exhaust port *E* and valve *F*. The inlet and exhaust ports and valves are situated in the cylinder head *G*. Fixed in a cylindrical recess *H* in the cylinder head and communicating with the inlet and exhaust ports is a regenerator matrix *J*, which is substantially cylindrical in form and may consist of a number of superposed layers of wire gauze. Close to the side of the matrix *H*, facing the cylinder *A*, is a fuel injection nozzle *K*. In operation, air is supplied to the inlet port after being compressed to a pressure slightly above the compression pressure by an external compressor not shown in the drawing. The engine works on a two-stroke cycle, in which the inlet valve opens shortly before top dead centre to admit the fresh charge, which then passes into and purges the regenerator. When this purging is substantially complete, the air, heated to a temperature sufficient to ignite the fuel, commences to enter the cylinder. Fuel injection commences shortly after top dead centre. The expansion or working stroke of the piston ensues, and the inlet valve is closed at a variable time during this stroke, depending on the power



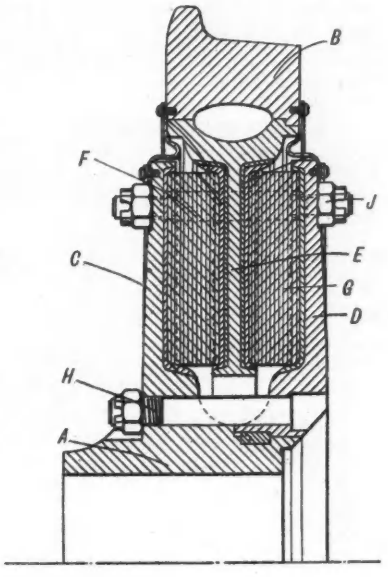
No. 640,410

output required of the engine. The exhaust valve opens shortly before bottom dead centre and the exhaust gas is ejected from the cylinder during the up-stroke of the piston, passing through the matrix *J* on its way to the exhaust port. The exhaust valve is closed shortly before the inlet valve is opened, and the cycle then repeats itself. In starting up the engine from cold it is necessary to provide either some means for pre-heating the regenerator, or an ignition plug for igniting the fuel during the first few strokes while the regenerator is warming up. In an engine constructed, the regenerator matrix consisted of twenty-four 3in diameter discs of 20 mesh by 28 gauge gauze, made of heat-resisting steel wire. After allowing for the volume of the matrix rendered ineffective by the locating shoulders in the cylinder head, the ratio of the matrix volume to the swept cylinder volume was approximately 5 per cent, the ratio of the volume of the dead space due to the matrix (that is, the overall volume of the matrix less the volume of the wire composing it) to the swept volume being somewhat less. The fuel injection was commenced at 30 deg. after top dead centre. The matrix had a thermal ratio of 70–80 per cent and the maximum thermal efficiency with this ratio was obtained with an expansion ratio of 3·5 : 1. The temperature at the hot end of the regenerator reached an equilibrium value of 900–1000 deg. Cent. Several alternative designs are shown.—*July* 19, 1950.

RAILWAY ENGINEERING

639,970. May 21, 1948.—Improvements Relating to Resilient Wheels for Rail Road Vehicles, Pirelli Societa per Azioni, of 94, Viale abruzzi, Milan, Italy.

This invention relates to resilient wheels for rail road vehicles of the type comprising a rigid outer portion carrying the rim of the wheel, and a rigid inner portion carrying the hub, elastically coupled together through the intermediary of resilient cushions of rubber or a like material sandwiched between, and in alternation with, a series of annular flanges disposed parallel to the general plane of the wheel and alternately connected to the outer portion of the wheel and the inner portion. The flanges have a freedom of movement towards and away from one another so as to be mutually tightenable on to the cushions in interposition between them, thereby determining as required the degree of pre-compression of the cushions, and the arrangement is such that the cushions are subjected to shear-flexion stress under the wheel load. As shown in the drawing, the wheel comprises a rigid inner portion carrying the hub *A* of the wheel, and a rigid outer portion carrying the rim *B*. These two portions are elastically coupled together through the intermediary of three flanges *C*, *D* and *E*, and sandwiched between these flanges in alternation therewith are two annular series of rubber cushions, of which two in axial alignment with one another are shown, marked respectively *F* and *G*. The flanges *C* and *D* are in rigid connection with the inner portion of the wheel and the intermediate



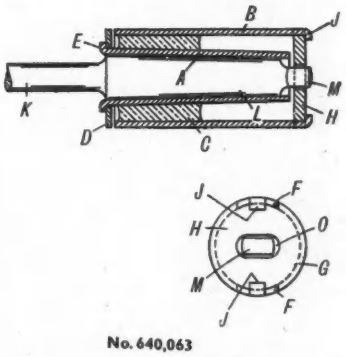
No. 639,970

flange *E* is in rigid connection with the outer portion of the wheel. The flange *C* is formed in one piece with the inner portion of the wall, the flange *D* being a separate entity from the inner portion of the wheel and mounted thereon in the manner shown in the drawing. The flange *E* is a separate entity from the outer portion of the wheel and is also mounted thereon as shown in the drawing. The two outer flanges are bolted together with the cushions, and the intermediate flange sandwiched between them, by means of two annular series of bolts, an inner series marked *H* and an outer series marked *J*. By varying the degree of tightness of these bolts the degree of axial pre-compression of the cushions *F* and *G* may be determined to suit the requirements of the wheel.—*July* 12, 1950.

TOOLS AND WORKSHOP APPLIANCES

640,063. January 5, 1948.—An Improved Floating Holder for Tools and the Like, George Arthur Bayley, of 34, Abercorn Gardens, Romford, Essex.

This invention relates to a floating holder for tools such as reamers. It has for one of its objects to provide an improved means of holding such tools in applications in which they have to be driven rotationally or held against rotation by the holder, and at the same time, are required to have a small degree of freedom to enable them to adjust themselves into alignment with the work operated



No. 640,063

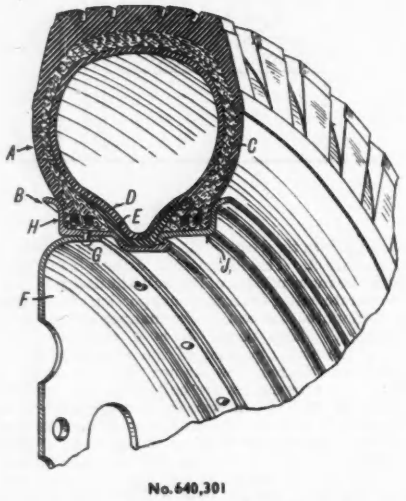
upon, or with another mechanical structure. Referring to the drawing, an inner tapering member *A* and an outer member *B* have an intermediate resilient lining *C* of vulcanised rubber bonded thereto which extends from the front end to about midway. A thrust ring *D* is located on the front end of

the inner member *A* which is prevented from becoming displaced by turned-over lugs *E* integral with the end of the inner member as shown. The rear end of the outer member *B* is provided with diametrically-opposed slots *F* to accommodate radial teeth *G* in a disc *H* and the end of the outer member is formed with turned over lugs *J* to prevent displacement of the disc *H*. A reamer *K* having a tapered shank *L* and a tongue like extension *M* is inserted into the inner member *A* and the extension passes through a transverse slot *O* in the disc, thereby forming a drive between the inner member and cuter member. The driving means for the reamer is provided between the teeth *G* on the disc *H* engaging with the slots *F* of the outer member, and intermediate rubber lining *C* provides the necessary freedom for floating and adjustment for any misalignment.—*July* 12, 1950.

ROAD TRANSPORT

640,301. December 17, 1947.—IMPROVEMENTS IN OR RELATING TO TYRE RIMS, The Firestone Tire and Rubber Company, of 1200, Firestone Parkway, Akron 17, Ohio, U.S.A. (*Assignees of William Kenneth Collette*).

This invention relates to tyre rims for use with pneumatic tyres, and more especially it relates to truck tyre rims on which are mounted tyres which in service are sometimes subjected to low inflation pressure. The chief object of the present invention is to provide an improved pneumatic tyre rim having both bead seats tapered, whereby tighter bead seats are obtained than has been possible before. Referring to the drawings it will be



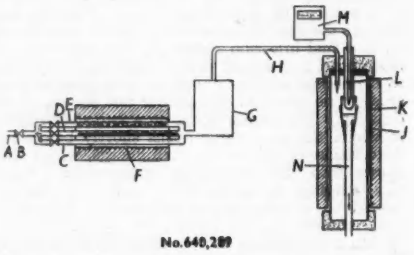
No. 640,301

seen that there is shown an assembly generally designated *A*, comprising an improved straight-side tyre rim *B*. The tyre rim has mounted thereon a tyre *C*, the latter including the usual inflatable inner tube *D* and flap *E*. The rim *B* is attached to a wheel, by any means found satisfactory as, for example, through the medium of a disc *F* to which the rim is attached by rivets *G*. In turn, the disc *F* is attached to a wheel hub, not shown. The tyre rim *B* comprises two endless annular members *H* and *J*. These members assembled as shown form a circumferentially split two piece rim. The operations of assembling and dismantling the components are described and illustrated.—*July* 19, 1950.

METALLURGY

640,289. October 6, 1947.—IMPROVED PROCESS FOR THE CEMENTATION OF STEEL, Gaz de France Ex-Société d'Eclairage Chauffage et Force Motrice, of 22, Rue de Calais, Paris, France.

This invention relates to a process for the cementation of steel by means of mixtures of gases manufactured from coal, known as town gases, which are distributed through town mains. The accompanying drawing is a diagrammatic representation of a plant according to the invention. The gas entering through a duct *A* carrying a cock *B* is distributed in several tubes *C*, *D* and *E*, each provided with an admission cock, the tubes being heated to a temperature of 900–1000 deg. Cent. by electrical resistances *F*. One of the tubes—*C*, for example—is empty. The heating causes the complete destruction by cracking of the hydro-carbons C_nH_m with the partial decomposition of CH_4 and CO_2. The tube *D* contains wood charcoal which reacts with CH_4 and CO_2, the hydrocarbons C_nH_m disappearing as in the preceding case. The tube *E* contains a catalyst, for example, iron filings at 900 deg. Cent. The gas obtained under these conditions has the following characteristics :—Absence of hydrocarbons C_nH_m, low CO_2 content, and high CH_4 content, and the absence of sulphur compounds. By operating the cocks the flow of the gas into the tubes can be regulated so that either the gas of one of them can be used, or a mixture of gas from several pipes can be utilised. The gas thus obtained is passed into a chamber *G*, where it is dehydrated either by passing it, for example, over a



No. 640,289

silica gel or by adequate cooling. An outlet pipe *H* runs into the chamber *J* of the cementation furnace, which, in the example shown, is heated by means of an electrical resistance *K* and is provided with upper and lower doors. The outlet for the gas is provided by a pipe *N*. The furnace chamber *J* is heated to a temperature of 900 deg. to 1000 deg. Cent., and in order to allow regulation of the heating the furnace comprises a thermo-electric couple *L* connected to a temperature indicator *M*.—*July* 19, 1950.

Personal and Business

CLIMAX MOLYBDENUM COMPANY OF EUROPE, Ltd., 2–3, Crosby Square, London, E.C.3, announces the appointment of Mr. H. L. Richardson as secretary in place of the Mr. G. F. Anderson, who has resigned.

ALFRED BULLOWS AND SONS, Ltd., Walsall, Staffs, has set up a process development advisory bureau under the control of Mr. A. Rice-Williams. The bureau offers a free consulting service on industrial finishes.

THE LAGAN ENGINEERING WORKS, of 5, Middlepath Street, Belfast, has removed to more extensive premises at 72, Tamar Street, Belfast. The firm remains under the control of Mr. Henrey C. Swinson and Mr. Samuel Swinson, sons of the founder.

THE FAIREY AVIATION COMPANY, Ltd., states that Air Commodore C. B. Wincott has been appointed general manager of its subsidiary, Fairey Clyde Aviation Company Pty., Ltd., Bankstown, Sydney, N.S.W., in succession to Air Commodore F. Kirk.

BRITISH OILFIELD EQUIPMENT COMPANY, Ltd., 32, Duke Street, London, S.W.1, states that it has acquired manufacturing and sales licences from the Cameron Ironworks, Inc., Houston, Texas, U.S.A., in respect of oilfield equipment of various descriptions.

MR. F. T. PULLIN has been appointed manager, and Mr. W. L. Cave, assistant manager, of RTSC Exports, Ltd., the company formed recently by Richard Thomas and Baldwins, Ltd., and the Steel Company of Wales, Ltd., to deal with exports of mild steel flat rolled products.

DEMAG-ELEKTROSTAHL, G.m.b.H., Duisburg, states that it has acquired the electrochemical section of Siemens and Halske, H.G. The name of the firm has been changed to Demag-Elektrometallurgie, G.m.b.H., its head office being situated at Bahnofsplatz 14, Karlsruhe.

Launches and Trial Trips

PROVENCE, passenger and cargo steamship; built by Swan, Hunter and Wigham Richardson, Ltd., for the Société Générale de Transports Maritimes à Vapeur, France; length 540ft, breadth 73ft, depth 34ft 6in, deadweight 7885 metric tons; two sets of single-reduction geared turbines taking steam from three Babcock and Wilcox boilers. Launch, August 14th.

SWIFT, cargo motorship; built by Henry Robb, Ltd., for the General Steam Navigation Company, Ltd.; length 196ft, breadth 35ft 6in, depth 20ft 4½in, deadweight 750 tons; Atlas Polar diesel engine, seven cylinders, 1120 b.h.p. at 250 r.p.m. Launch, August 15th.

BRITISH SURVEYOR, motor tanker; built by Harland and Wolff, Ltd., for the British Tanker Company, Ltd.; length 463ft, breadth 61ft 6in, depth 34ft, deadweight 12,300 tons; Harland-Burmeister and Wain single-acting, four-stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke. Launch, August 15th.

ANDVARI, steam trawler; built by Hall, Russell and Co., Ltd., for the Icelandic Government; length 183ft 6in, breadth 30ft, depth 16ft; triple-expansion steam engine, 1000 i.h.p. Launch, August 15th.

BRITISH SPLENDOUR, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the British Tanker Company, Ltd.; length 547ft, breadth 69ft 6in, depth 37ft 6in, deadweight 15,875 tons; Wallsend-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6400 b.h.p. at 115 r.p.m. Launch, August 16th.

HERMUS, motor yacht; built by Brooke Marine, Ltd., for Lieut.-Colonel Musgrave-Hoyle; length 55ft 9in, beam 12ft 6in, displacement 28 tons; two Gleniffer diesel engines. Launch, August 17th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

British Association

Wed., Aug. 30th, to Wed., Sept. 6th.—Annual meeting in Birmingham.

British Institution of Radio Engineers

Wed., Sept. 27th.—London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, Annual General Meeting, 6.30 p.m.

Incorporated Plant Engineers

Mon., Sept. 4th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Heat Transfer from Condensing Steam," C. R. Crosse, 7 p.m.

Tues., Sept. 5th.—S. WALES BRANCH: Grand Hotel, Westgate Street, Cardiff, "The Applications of Ultrasonic Testing to Plant and Maintenance Engineering," J. W. Fox, 7.30 p.m.

Thurs., Sept. 7th.—PETERBOROUGH BRANCH: Eastern Gas Board's Demonstration Theatre, Church Street, Peterborough, talk by the President, E. G. Phillips, 7.30 p.m.

Tues., Sept. 12th.—E. LANCASHIRE BRANCH: Engineers' Club, Albert Square, Manchester, "Ventilation and Heating," E. S. Hancock, 7.15 p.m.

Institute of Metals

Mon., Sept. 18th, to Fri., Sept. 22nd.—Forty-Second Annual Autumn Meeting at Bournemouth.

Institute of Petroleum

Wed., Sept. 13th.—Manson House, 26, Portland Place, London, W.1, "Carbon Black Manufacture," L. W. Cabot and J. W. Edminster, 5.30 p.m.

Institution of Engineering Inspection

Wed., Sept. 6th.—BIRMINGHAM BRANCH: Chamber of Commerce, Room 3, Birmingham, "Industrial Relations," Vincent Everard, 7.30 p.m.

Tues., Sept. 12th.—COVENTRY BRANCH: Technical College, Room A5, Coventry, "Petroleum and Products," films illustrating production and manufacture processes, 7.30 p.m.

Institution of Metallurgists

To-day to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 10.0 a.m. to 6.0 p.m.; Sundays, 2.30 p.m. to 6.0 p.m.

Institution of Mining and Metallurgy

Tues., Sept. 19th, to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Institution of Production Engineers

Tues., Sept. 5th.—LIVERPOOL GRADUATE SECTION: Exchange Hotel, Liverpool, "Lay-Out for Production," O. Blenkinsop, 7.45 p.m.

Wed., Sept. 6th.—LIVERPOOL SECTION: Radiant House, Bold Street, Liverpool, "Lighting for Production," W. Robinson, 7.15 p.m.

Sat., Sept. 9th.—BIRMINGHAM GRADUATES' SECTION: visit to Ansells Brewery, Ltd., Aston Brewery, Birmingham, 6, 10 a.m.

Mon., Sept. 11th.—MANCHESTER GRADUATE SECTION: College of Technology, Sackville Street, Manchester, "Television," T. Worswick, 7.15 p.m.

Tues., Sept. 12th.—BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, film evening, 7 p.m.——DUNDEE SECTION: Mather Hotel, Whitehall Crescent, Dundee, "The Function of Time Study in the Modern Manufacturing Organisation," S. I. Rastall, 7.30 p.m.——WOLVERHAMPTON GRADUATE SECTION: Technical College, Wolverhampton, "Petroleum and Petroleum Lubricants," J. Romney, 7 p.m.

Scientific Instrument Manufacturers' Association

Tues., Sept. 5th, to Fri., Sept. 8th.—Exhibition and Symposium at the Examination Hall, Queen Square, London, W.C.1.